THE ASTRONOMICAL REGISTER.

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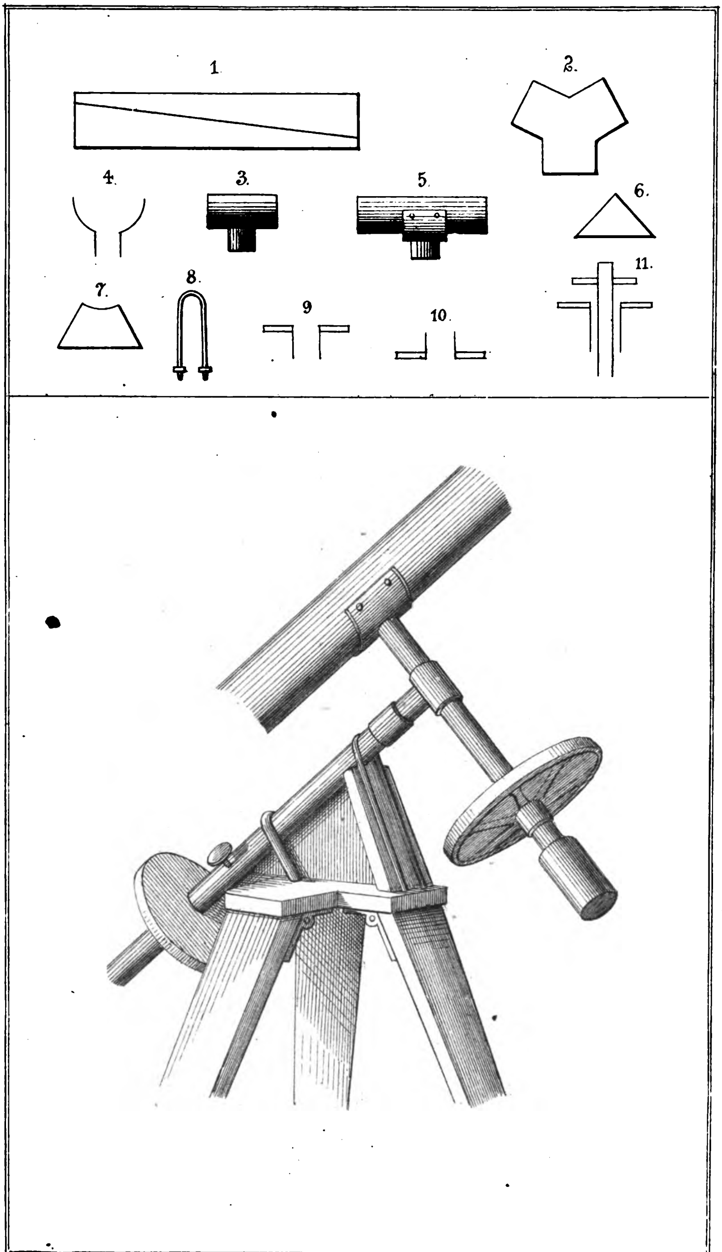

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CONVENIENT AND INEXPENSIVE.

By P. Vallance, Esq.

THE

ASTRONOMICAL REGISTER:

A MEDIUM OF COMMUNICATION
FOR AMATEUR OBSERVERS, AND ALL OTHERS INTERESTED IN THE
SCIENCE OF ASTRONOMY.

VOL. II.

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INDEX TO VOLUME II.

ENGRAVINGS.

The Astronomical Register.

No. 13. JANUARY. 1864.

ON THE COMPANION OF SIRIUS.

A very curious and interesting memoir has reached us from America within the last few weeks on the observed motions of the companion of Sirius. The author, Mr. Safford, of Harvard College, Mass., treats the subject in detail, and a compendious analysis of his remarks can scarcely fail to be acceptable to English astronomers. Anomalous irregularities in the motion of Sirius were recognised even as far back as the time of Bessel, who pronounced them to be necessarily due to the disturbing force of some unknown companion, unless we chose to question the universality of the law of gravitation. C. A. Peters, some years later, computed such of the elements of the motion of Sirius around the centre of gravity of the system as could be deduced from the motions in right ascension; and Schubert pointed out that there was some reason to believe that the motion in declination was also irregular, though he seems to have fallen into error in supposing that the motions in right ascension and declination were not completed in the same period.

In September, 1861, Mr. Safford sent to Professor Brunnow the results of an investigation he had conducted in reference to the perturbations of Sirius. He found himself able to announce, with tolerable certainty, the angle of position of the centre of gravity with respect to the visible mass, and thus the angle of position of the supposed invisible companion. This was for—

Epoch, 1862·1 . . . 83·8° (yearly diminution 1·4°).

Scarcely four months after this determination was arrived at, and within five weeks of its actual publication, Mr. Alvan Clark discovered

(as is well known) a companion to Sirius, whose angle of position was determined by the several observers under-named to be—

	Epoch		
Bond	1862·2	=	84·6
Chacornac	1862·2	=	84·6
Lassell	1862·3	=	83·8
Rutherford	1862·2	=	85·0

The close coincidence here exhibited was obviously too remarkable to be passed over. Mr. Safford proceeds to point out that there are three hypotheses logically possible with respect to the new star. It may be either unconnected with the system of Sirius, or secondly, a satellite, but not the disturbing body; or thirdly, the disturbing body itself.

Assuming the little star to be fixed, the position and distance by Hypothesis I., in consequence of the proper motion of Sirius, would be, for—

	°	″
1863·0	79·1	10·80
1864·0	73·3	11·69

The second hypothesis gives no ground for calculation, and it will be considered farther on. The third hypothesis (Safford's own investigations being corrected so as to agree in 1862·2 with observation, by $+ 0·9°$) would give—

	°
1863·0 . . .	83·5
1864·0 . . .	82·1

observation gives, compared with these hypotheses,

	°		°		°
1863·3 Bond . .	82·8 . .	Hyp. I.	77·4 . .	Hyp. III.	83·1
1863·2 Rutherford .	81·2 . .		77·9 . .		83·2

	Computed I.	Observed III.
Bond . . .	$-5·4°$ . . .	$+0·3°$
Rutherford .	$-3·3$ . . .	$+2·0$

To which must be added, that the first hypothesis requires an increase of distance between 1862·2 and 1862·3 of 0·8″; the third, a very slight diminution; but observation indicates a diminution of about 0·55″, a quantity, to use Mr Rutherford's expression, "so small that it cannot be asserted with confidence." It is hardly conceivable that the long and careful series of observations of Mr. Rutherford should be in error 3·3°; and also inconceivable that Professor Bond's measures, agreeing as they do within 2° 20′ among themselves, should be in the mean 5·4° erroneous. We have therefore nothing to oppose *the hypothesis that the new companion is the disturbing body* but the very improbable supposition that the small star partakes very nearly of the

great proper motion of Sirius, without any physical connection; or the second hypothesis, that the new star is in the system, but of a small mass. If this is the case, the disturbing body must, in lieu of the small light of the companion, have still less, or even be absolutely invisible. "It is consequently highly probable that the disturbing body has been actually found; that that which was predicted by theory has been confirmed by sight." The importance of continued observations on Sirius cannot be too highly insisted on. The companion must be measured during the present winter, and for several successive years, while Sirius itself should be reobserved with meridian instruments. These full particulars of the substance of Mr. Safford's memoir are given because of its novelty and intrinsic importance. A somewhat startling supposition must, however, be adopted if the surmise that the companion really produces the disturbances be believed, as Safford says it must be. This is, that the faint object barely visible in the largest class of telescopes must have a mass nearly *two-thirds* that of Sirius itself.

G. F. C.

ROYAL ASTRONOMICAL SOCIETY.

Second Meeting, 11th December 1863.

The Astronomer Royal, *President*, in the chair.

Secretaries, the Rev. C. Pritchard and Mr. Hodgson.

Thirty presents were announced, among them the following:—Tables of logarithms, &c. from Miss Sheepshanks, arranged by her late brother; the conclusion of Argelander's survey of the northern heavens; an Essay on "*the Yard, the Pendulum, and the Metre*," by Sir John Herschel (concerning which the Astronomer Royal observed it settled the question decisively that we did not require to go to the metre for a measure of length); and a volume of the "Edinburgh Astronomical Observations," showing that Professor Piazzi Smyth had not been backward in his work lately.

C. G. Talmage, Esq.

was balloted for and duly elected a Fellow of the Society.

Mr. Stone read a paper "*on the movement of the Solar System in space*," in reference to which the president remarked, that the conclusions as to the movement of the Solar System were founded on the proper motion of the fixed stars, which was very small in general, and in it

great anomalies had been met with, from the time of Bradley in 1750–1760 to the present day. Our first knowledge was derived from the research of Sir William Herschel, who discussed the observations of stars having large proper motion; and subsequent investigations have been carried on by other astronomers on the one principle of referring the movements of the stars to the motion of our sun in space, and they have all arrived at nearly the same point. Mr. Airy went on another plan, viz.: that the sun might have one motion, and the stars others, which are unknown; and he also arrived at a result as to the point towards which the Solar System was moving, which agreed well with the previous enquiries. Mr. Airy used the proper motions of 318 stars, and Mr. Dunkin afterwards investigated those of 1,119, and obtained a similar result. But the question was this, whether the sum of the squares of the residual errors was greatly diminished or not, and it was curious that in these investigations it was very little diminished. "I therefore," continued Mr. Airy, "asked Mr. Stone to examine the matter, as I may say, *maliciously*, to discover if there were not some error: he has gone into it and can find nothing wrong. Supposing that Bradley made errors of right ascension, that might account for a good deal; but the matter is left in a most delightful state of uncertainty, and I shall be very glad if any one can help us out of it."

A paper by Mr. Dawes, containing remarks "*on the Telescopic Appearance of the Envelopes of the Sun and its Spots*," was read by Mr. Hodgson. The appearance of the solar surface is very different when viewed by instruments of large aperture to that which is seen in telescopes of smaller size; and if a new name is given to what has long ago been observed, merely because of its difference of appearance, it leads to error. The mottled surface of the sun can be seen with a low power; it has been variously described, and appeared to Mr. Dawes in many ways, but he had not been able to verify the appearance of the so-called "willow leaves" described by Mr. Nasmyth. He had studied the subject for the last ten or twelve years with various instruments, and on the whole, the words used by Sir John Herschel, in his *Outlines of Astronomy*, that "the surface is like some flocculent chemical precipitate slowly settling down," are by far the best description of the appearance of the solar disc. Mr. Dawes uses a very small perforation in the eye-piece, with high powers—400 to 600—and rarely sees much change in the pores, except in the vicinity of spots which are rapidly expanding or closing, when the appearance of the surface at the margin resembles small bits of straw or thatching interlacing in all directions. With regard to the spots in the black centres, distinction ought to be made between the umbra and the nucleus; the existence or absence of this black central portion may possibly determine the origin of the spot.

The Astronomer Royal noticed the importance of this communication, especially as to the black nucleus, and the appearance of what Mr. Dawes called "straws" or "thatching" on the edges of the spots, and enquired whether any members present could add to the description of the solar phenomena.

Mr. Huggins stated that he had examined the sun with his eight-inch telescope, with Mr. Dawes's eye-piece, and also with the glass reflector known as Mr. Hodgson's, having especial reference to the point in question, and agreed with Mr. Dawes that he could see nothing of the character of "willow leaves."

The Astronomer Royal.—Although you do not find any of the appearances on the great mass of the sun, do you not find something like "willow leaves" at the margin of the spots?

Mr. Huggins.—Yes. At the margin of the spots there is a radiated structure, but I much prefer Mr. Dawes's name of straws or thatching.

Mr. Pritchard observed that Sir John Herschel had written to Mr. De la Rue and himself on the subject, and described the appearances as a "slow precipitation of flocculent matter." "The sun," continued Mr. Pritchard, "is covered with small objects—bits of straw, flocculent matter, or what you like—exceedingly brilliant and different from the other parts of the surface; and this not only in the neighbourhood of the spots. It matters not what you call them—there they are; and Sir John Herschel's description is perhaps better than Mr. Nasmyth's. The 'willow leaves' were wanted. An incandescent liquid or gas, such as we suppose the sun's atmosphere to consist of, will not give out light: we therefore wanted something floating in it, or where could the light come from? The advancing state of our philosophy required the willow leaves, and they came just in the nick of time."

Mr. Hodgson said that he had perhaps examined the sun's surface as much as any one present, and these appearances to him resembled a "brain coral" viewed at a distance. Nothing of a lenticular form, such as Mr. Nasmyth depicted, had ever been seen by him.

Mr. De la Rue observed that, looking by chance through Mr. Pritchard's telescope (6-in. aperture, by Cooke), he exclaimed, "What a splendid object-glass you have got—there are Nasmyth's willow leaves!" They appeared like bars overlying each other. He had since seen the same objects with a telescope by Dallmeyer, of 4⅛-in. aperture. With regard to the incandescence of the sun's envelope, he might say that a gas, however highly heated, is transparent: it requires the interposition of a solid body to produce light.

In answer to the Astronomer Royal, Mr. De la Rue said that these appearances took place all over the sun's disc, in parts perfectly free from spots, and added that photography showed that the sun's surface was extremely mottled.

Mr. Howlett, using an object-glass of 3-in. aperture by the elder Dollond, had never seen anything of the nature of willow leaves. "What I see is like the appearance presented by soapsuds in hard-water, when subsiding after standing some time, and this curdled appearance occupies the whole of the sun's disc. There is a rugged margin to the blackness in the centre of the spots, and a *woolly* sort of appearance about the nucleus generally: the only approach I have ever seen to anything like the willow leaves has been upon the penumbra of the spots. I use a screen in preference to a direct view of the sun, and see much more by that means, especially a difference of tint, in parts of the umbra corresponding to Mr. Dawes's nuclei."

Mr. Carrington said he believed that the unsilvered glass speculum was best adapted for viewing the sun, and should be glad if any gentleman who had used it for that purpose would give his experience on the subject.

The Astronomer Royal stated that thirty years ago Sir John Herschel, at Slough, showed him the sun with a 9-in. glass speculum, no doubt very finely figured, and he had such a view of the sun as he had never had since, and saw the mottled appearance all over the surface. "It is fresh upon my mind now, and I call it a flocculent appearance: it looked to me something like the smoothest 'oiled paper;' and I believe a better image of the sun may be got in that way than in any other."

Dr. Hofmann, who was present as a visitor, in answer to a question as to the luminosity of gases, asked, what is luminosity? Hydrogen burns with a flame not visible at a distance: introduce a solid, and it becomes luminous; but other gases burn with a coloured flame: is this not luminous? As to the appearance of the willow-leaves, he said that chemists were as anxious about forms as astronomers. "We obtain, let us say, a precipitate; we consider it to be crystalline: now crystals are often extremely minute, and although I have never heard of crystals appearing like willow leaves, I have seen crystals which look like—cauliflowers! With one particular precipitate, *I* thought it like 'cauliflowers,' one assistant said it resembled 'palm leaves,' another 'fern leaves,' and the last saw only precipitate! This little circumstance came into my mind when I heard the discussion about the 'willow leaves.'"

Mr. De la Rue stated that gases when very highly heated, passing through transparent tubes, were non-luminous, while the solid contents of the tube gave out light, and appealed to Dr. Hofmann to corroborate this.

Dr. Hofmann.—If we burn pure hydrogen and oxygen the flame is

perfectly non-luminous, and only becomes luminous on the introduction of solid matter.*

The Astronomer Royal exhibited and explained a micrometer microscope, in which the milled head held by the finger and thumb was made conical instead of cylindrical, thus obviating the tendency of the screw to be disturbed in its position by the involuntary action of the fingers pulling against the spring.

Mr. Carrington said that, as observations were now carried not only to tenths but to hundredths of seconds, anything tending to do away with errors was highly to be applauded.

A continuation of Mr. Howlett's drawings of solar spots was received and acknowledged by the Astronomer Royal.

Upon the application of Mr. Whitbread, the treasurer, the names of two gentlemen were suspended for expulsion on account of arrears of subscriptions due to the society.

The meeting then terminated.

RECENTLY NAMED LUNAR CRATER.

Mr. Birt has communicated to us the following list: —

I. North-West Quadrant.

		Lat.	Long.
405.	The Coxwell Mountains ...	10° N to 15° N ...	45° W
406.	Mount Glaisher	15° N ...	46 W
407.	Chevallier	45 N ...	50 W
408.	Moigno	63 N ...	25 W
409.	Peters	68 N ...	25 W

II. North-East Quadrant.

410.	The Teneriffe Mountains	42° N to 48° N ...	3° E to 18° E
411.	Piazzi Smyth	42° N ...	3° 30′ E
412.*	Herschel II.	58 N to 64 N ...	30 E to 40 E
413.*	Robinson	58 N to 63 N ...	40 E to 50 E
414.*	South	55 N to 58 N ...	45 E to 53 E
415.	Babbage	57 N to 62 N ...	52 E to 60 E

III. South-East Quadrant.

416.	The Percy Mountains ...	17° S to 25° S ...	41° E to 53° E
417.*	Rosse	53 S to 60 S ...	48 E to 55 E

* Dr. Hofmann, in replying, seemed not quite to have understood the question. There is, however, no doubt that Mr. De La Rue's statement was correct as to gases when highly heated, and either incombustible or prevented from burning, being non-luminous at temperatures when solid bodies become white hot.—Ed.

IV. South-West Quadrant.

418.	J. Franklin ...	12° 30′ S to 15° 30′ S ...	47° W to 52° W
419.	Crozier	15° S ...	50° W
420.	M'Clure	15 S ...	48 W
421.	... ...	13 S ...	49 W
422.	Wrottesley	23 S ...	56 W
423.	Phillips	24° S to 27° S ...	75° W to 80° W
424.*	The Mare Smythii	3 N to 9 S ...	80 W to 95 W

Those marked * are unrepresented on Beer and Mädler's large map, but some very imperfect indications of them exist.

The authority for the Selenographical co-ordinates is Beer and Mädler's map. They, however, require a careful redetermination.

CORRESPONDENCE.

N.B.—We do not hold ourselves answerable for any opinions expressed by our correspondents.

THE PLANET "VULCAN."

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—In the "Literary Notices" of your last number, you direct attention to a "Parochial Lecture on Astronomy," by Mr. G. F. Chambers. In that lecture he alludes to the Planet *Venus* as "*the third*" in the order of distance from the Sun. If this be intended as implying a belief in the existence of the Planet *Vulcan*, between the Sun and *Mercury*, can you, or any of your correspondents, inform the public what substantial foundation there is for such a belief?

In Mr. Hind's interesting letter to the *Times*, of September 17 last—briefly epitomised in the *Astronomical Register*, No. 11, for November—it will be seen that M. Le Verrier does not recognise the existence of the Planet *Vulcan*, but interpolates "a ring of asteroids between the Sun and *Mercury*, the aggregate mass of which is comparable to that of *Mercury*," in order "to account for certain anomalous motions" of *Mercury* and other planets, when tested by a "most rigorous application of the theory of attraction." *My* interest in this question you will understand.

JUNO.

December 15, 1863.

THE EARTH'S ORBIT.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—Your periodical having given us, in the last number, the new calculations regarding the Earth's distance, &c. is a good instance of the advantages of such a work. Did you, however, notice an error in the Earth's orbit, which was stated to be 599,194,000? Now, 91,328,600 × 2 × 3·1416 make it 573,835,860—"nearly."

I am, sir, yours, much obliged,

Burbage, November 28. SENEX.

VISIBILITY OF THE DARK SIDE OF VENUS.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—Observing upon the day referred to in your last Number, page 190, that the unilluminated disc of Venus was very distinctly visible with my 5-ft. refractor, aperture $3\frac{7}{8}$ in. I turned upon it a good 44-in. Dollond, $2\frac{7}{8}$ aperture, and found that, although fainter, it was still quite discernible with a power of 40.

It may, therefore, interest those of your readers who do not possess large instruments to learn that the observation of this curious phenomenon does not, under favourable circumstances, require the aid of great optical power.

N.B.—The time was about 11h. a.m.

I am, sir, your obedient Servant,

Ealing, December 21, 1863. W. L. BANKS.

PARALLACTIC LADDERS AND STANDS.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—In your last number a correspondent strongly recommended the use of what is known as the "Parallactic Ladder."

May I inform your readers that I have seen a most excellent stand made by Mr. Slugg, of Manchester, which embraces all the excellencies of the ladder, without its defects?

I remain,
Your obedient Servant,

Marton, December 11, 1863. J. B.

LUNAR MOUNTAINS.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—The Rev. T. W. Webb, in his most instructive little book, "Celestial Objects for Common Telescopes," thus speaks of the Lunar mountain La Hire:—"There is nothing striking in its usual appearance, but it was twice seen by Schröter, under very different illuminations, so brilliant as to glitter with rays like a star: he noticed also changes in its form. . . . . I once found it on the terminator, 2d. 7h. after first quarter, the brightest object in sight, and radiating as described by Schröter. On another occasion I noticed a similar hill on the other side of Lambert, about one-third of the distance from Lambert to Timocharis, glittering on the terminator like a star with rays." On the 19th, about 9h. 15m. G.M.T., I saw this latter hill exhibit the above phenomenon in a most striking manner. With a power of

120 on my five-foot equatorial I was examining the whole length of the terminator, when this hill came into the field, and at once rivetted my attention by its singular brightness. The hill shone out very splendidly, accompanied by brilliant flashes. I have an impression that the flashing was connected with the object not being strictly in focus, but had hardly time to satisfy myself on this point, as a thin haze spread over the sky, and very shortly everything was obscured. About 11h. it was again pretty clear, and on directing the telescope to the hill, I found it far advanced on the terminator, so that the shadow was visible. It was still 'the brightest object in sight,' though its original brilliancy was much diminished. When first seen at 9h. 15m. it gave me the impression of very far surpassing in brilliancy anything I had ever previously seen on the Moon's surface.

I am, Sir,

Yours obediently,

GEORGE HUNT.

Edgbaston, Birmingham,
November 21, 1862.

THE LUNAR CRATER TYCHO.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—May I enquire through your columns if any of your readers are able to refer me to any authorities in which the fine Lunar Crater Tycho is described as having a *double* central mountain? I quote the following from my records made at the time specified:—

HARTWELL OBSERVATORY.

1863, October 21d. 20h. 9m. L.S.T. A small hill in Tycho, west of the central one.

VICTORIA OBSERVATORY, LONDON.

1863, November 20d. 5h. 45m. G.M.T. The small cone in Tycho is exceedingly distinct, also the shape of the central mountain, the summit gradually descending to the NE. Beer and Mädler have not in the least indicated this secondary cone. I do not see the two hills SE. of the central cone which they depict.

Mr. Horton, Dr. Lee's assistant, who was with me when I saw the small cone at Hartwell, also observed it. A very strong indication of it exists in one of Mr. De la Rue's photographs. It is low, and situated on the west side of the central mountain, to which it is very close.

The Rev. T. W. Webb kindly informs me that nothing of the second peak occurs in Schröter, who measured the central mountain carefully, or in Beer and Mädler, though they say there are several unevennesses in the interior hard to be made out, because of the late retreat of the Shadow, which does not occur till hillocks in that situation lose theirs.

I did not observe this smaller cone in Tycho before October 21, although I have very frequently inspected the crater earlier than that date.

I am, Sir,

Your obedient Servant,

W. R. BIRT.

Victoria Observatory,
Victoria Park, London,
December 3, 1863.

THE MOON'S ROTATION.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—A friend of ours has taken the trouble to *versify* "The Moon Controversy," and authorises me to offer you a copy, which I enclose. If you have space, I think it may interest some of the sisters, wives, and daughters of your subscribers—and, probably, others also—who may like to know the *purport* of the controversy, but who may not be inclined to study the "why and wherefore" in technical prose.

Yours very faithfully,
HENRY PERIGAL, Jun.

57 Warren Street, Fitzroy Square,
December 10, 1863.

THE MOON CONTROVERSY.

Part I.—Explanation.

I.

The Moon, to-night so round and clear,
A fortnight hence will disappear;
But at the close of two weeks more
Will show a disc round as before;
And after other fourteen days
Again will vanish from our gaze.
The *New Moon*, in a day or two,
A slender *Crescent*, meets our view;
Then, having "filled her horns," we soon
Behold a *Half*, or *Demi-Lune*.
Next, aged about some seven days,
She enters on the *Gibbous phase*;
And gaining hourly still more light;
Continues *gibbous*, but more bright;
Till, on the fourteenth night, is found
Again a *Full Moon's* perfect round,
Which, *waning* by degrees, we trace
The *gibbous*, *half-moon*, *crescent* face:
Each *phase* recurring as before,
Successively for evermore.

II.

Attentive observation shows
That—while the moonlight she bestows
Thus fluctuates—we only trace
A slight "*Libration*" of her *Face*.
The portions seen at any time—
By night or day, in ev'ry clime,

If gibbous, crescent, half, or new—
Are all, when full, at once in view.
  The Moon, 'tis consequently clear,
To Earth turns only half her sphere;
And to that half, and that alone,
The Earth itself is only known.
The other half, by will Divine,
On Earth is never found to shine.
While mortals, "who on Earth do dwell,'
Can nothing of that portion tell:
Its habitants, if any be,
The Earth, from their half, never see:
Though, from the other hemisphere,
The Earth can never disappear!

III.

  Now why is this?—We want to know
The reason it is always so.—
Why is it half the Lunar sphere
Is *never* visible from here?
How do the Laws of Motion act
To cause this interesting fact?
  The Moon, astronomers feel sure,
Makes round the Earth a monthly tour:
And also (which on faith a tax is)
In same time turns about her axis.
Rotation and the circumvection—
Each acting in the same direction,
From west to east, as they proceed
With (round each centre) equal speed,
Though separate, yet both combined,
Producing the effect opined.
  Thus folks, who advocate this notion,
Ascribe to her a *double motion*;
Resulting from cooperation
Of *Revolution* and *Rotation.*

IV.

  But others say she don't *rotate*,
If round the *Earth* she circulate;
For incompatible with *facts* is
The said Rotation round her axis!
  None disapprove the appellation
Of Revolution or Rotation:
For both are proper terms to use:
Words more correct one could not choose.
But call them by whatever name,
Their joint effect would be the same.
Such *double motion* won't produce
The consequences they deduce;
But just the *contrary* effect
To what these theorists expect:
Did she rotate, we should discern
The whole of her at every turn.

Contested thus by adverse sages,
The Lunar Controversy rages;
To be, from time to time, renewed—
Till truth prevailing end the feud.

THE MOON CONTROVERSY.

Part II.—Facts and Reasons.

V.

The advocates of Moon's Rotation
Should take into consideration
That, if a fixed, or moving line
The centres of two spheres combine,
When either of the two turns round,
The moving surface will be found
(As patent on investigation)
To cross this line at each rotation;
Unless one body circulate
Round t'other, and the last rotate
Exactly at an equal rate.
A case in point, for illustration,
Is proffered by the Earth's rotation.
Suppose, from Earth, a line drawn through
The Sun, the Moon, a Star or two;
As Earth rotates, it plainly must
Across these lines transport its crust.
As our rotation brings to view
The *Sun*, Moon, Stars and Planets too,
What would the Moon's Rotation do?

VI.

By their own symbols self-deceived,
Astronomers too long believed
The now disproved sophistication
That *turning round* implies *Rotation*.
Some fancy if a globe be found
To show all sides to all around,
It must, in doing so, *rotate*:
But herein they miscalculate;
For revolution, too, is found
Another mode of turning round.
No matter if it turn about
An axis in, or centre out
Of, its own orb; in either case,
The *turning* causes change of face.
When soldiers "wheel," in changing ground,
They change their front by turning round

The "pivot" man. While he, alone,
Turns round an axis of his own,
The rest *revolve* or *orbitate*:
In "facing," one and all *rotate.*

VII.

It's often confidently stated
(By those who've *not* investigated)
That planets, did they circles trace,
Would parallelism keep in space:
Adopting Galileo's notion
That such is but a *single motion.*
Of course, were this assumption *true,*
So were the Moon's rotation too.
But it is nothing more than fiction,
Which oft has met with contradiction:
By analysing the effect
(At least) *two movements* we detect.
The simplest possible causation
Is revolution with rotation,
Or two concurrent circumvections,
Which move in *opposite* directions;
And having same velocities,
Each other, therefore, neutralise:
Unturning as the other turns,
Each spends what its companion earns.

VIII.

A full investigation shows—
As ev'ry one who tries it knows,
And any one may ascertain
Who tests it thoroughly again—
The dogma of the Moon's Rotation
Admits of no substantiation.
Would Mathematicals—forsooth—
If true, have failed to prove its truth?
Would not they—if they could—submit
Some overwhelming proofs of it?
But still it totters *proofless*!—Hence
There's strong presumptive evidence
None do—or can—such proof propound,
Because *the dogma is unsound.*
For, were there means of doing so,
They would have proved it long ago.
In fine—*the Moon does not rotate,*
If round the Earth she circulate:
But, *if the Earth revolves round her,*
She does rotate—as facts aver.

CYCLOPS.

London, July 19, 1863.

P.S.—The doctrines I impugn
Are not restricted to the Moon!

NOTES AND GLEANINGS.

Astronomy in the Southern Hemisphere.—The Legislature of Victoria, New South Wales, having recently voted £5,000 for the foundation of a new Royal Observatory in that colony, a committee has been appointed in England to look out for a large reflecting telescope, capable of doing service to science, especially in the scrutiny of nebulæ. Mr. Lassell, having heard of what is in contemplation, has generously come forward with the offer of his fine instrument as a gift, so soon as his Malta observations are concluded. It remains to be seen whether this noble donation is accepted.

M. Weisse, of Cracow, the distinguished editor of Bessel's *Star Zones*, died at Cracow on October 10, aged 65.

Comet IV., 1863.—

1864	R. A. h. m. s.	Decl. ° ′	1864	R. A. h. m. s.	Decl. ° ′
Jan. 1	17 40 24	+33 40·0	Jan. 5	17 52 50	33 48·8
2	17 43 38	33 42·2	6	17 55 44	33 51·0
3	17 46 47	33 44·4	7	17 58 34	33 53·1
4	17 49 51	33 46·6	8	18 1 24	+33 55·2

This comet (see our last number) is named as V. in some other journals, but as its P. P. precedes that of the other comet, it is entitled to a prior place by well-established custom.

Comet V., 1863.—The following ephemeris is by M. Engelmann, of Leipsig:—

Berlin Mean Noon.

1864.	R. A. h. m. s.	Decl. ° ′	1864.	R. A. h. m. s.	Decl. ° ′
Jan. 1	17 55 35	+34 39·6	Jan. 17	18 49 14	27 58·6
2	17 59 40	34 11·9	18	18 51 55	27 36·8
3	18 3 38	33 44·5	19	18 54 32	27 15·4
4	18 8 29	33 17·4	20	18 57 5	26 54·4
5	18 11 14	32 50·7	21	18 59 35	26 33·7
6	18 14 53	32 24·3	22	19 2 1	26 13·4
7	18 18 26	31 58·3	23	19 4 24	25 53·5
8	18 21 53	31 32·6	24	19 6 44	25 34·0
9	18 25 15	31 7·3	25	19 9 1	25 14·8
10	18 28 31	30 42·4	26	19 11 15	24 56·0
11	18 31 43	30 17·8	27	19 13 26	24 37·5
12	18 34 50	29 53·6	28	19 15 34	24 19·4
13	18 37 52	29 29·8	29	19 17 40	24 1·7
14	18 40 49	29 6·4	30	19 19 43	23 44·3
15	18 43 42	28 43·4	31	19 21 44	23 27·3
16	18 46 30	28 20·8			

The distance of the comet from the earth is as follows:—January 1, 1864, 149,115,000 miles; January 31, 178,600,000 miles. On December 31, 1863, this comet will be distant from Comet IV. by only 3·87° of a great circle. On January 1 its brightness is 2·12; on January 15, 1·66; on January 31, 12·8. Oppolzer states (*Ast. Nach.* December 18) that he can obtain no signs of ellipticity. Both this comet and No. IV. will be visible for some months to come.

New Catalogue of Nebulæ. — Another splendid monument of Herschelian genius was laid before the Royal Society on Thursday week, a gigantic catalogue of all the known nebulæ compiled from every imaginable source. No less than 5,063 objects are here set down, of which 2,307 are from Sir John Herschel's own catalogue of 1833, 1,713 from his Cape observations, and the residue from miscellaneous sources. The year 1860 has been adopted as the epoch for which all the mean places are computed, and not the least important feature is the systemised plan which has been adopted for describing the sizes of the various objects based on direct actual admeasurement. This catalogue, which will add one more to the many laurels already borne by its distinguished author, will, no doubt, be placed in the printer's hands with as little delay as possible, but the expense of printing it will be very considerable.—*English Churchman.*

Schmidt's New Planet is supposed to be Hygeia. It is not a little wonderful that a mistake of this kind is not made oftener than it is.

Earthquakes: The Earth's Density.—A long and very interesting article appears in the December *Church and State Review.* The writer (anon.) expresses a confident belief that earthquakes are electrical ebullitions in the earth's crust; and, further, that the geological hypothesis of the central portions of the earth being fluid is untenable, for this reason: the specific gravity of the whole globe is 5½; of the surface crust, 2½: so that the interior must, of reality, have a density greater than the mean, instead of less—a surmise at variance with the supposition of a fluid interior.

Original Notion of Comets.—There is something highly original in the notions of celestial mechanics entertained by an honest Scottish Fife lass regarding the theory of comets. Having occasion to go out after dark, and having observed the brilliant comet then visible (1858), she ran in with breathless haste to the house, calling on her fellow-servants to "Come oot and see a new star that hasna got its tail cuttit aff yet!" Exquisite astronomical speculation! Stars, like puppies, are born with tails, and in due time have them docked.—*Dean Ramsay's Reminiscences of Scottish Life.*

Sound of Meteors.—In a note to the *Times*, Mr. Vertu says: "While observing the threatening aspect of the north-west sky, a rustling, hissing sound made me turn round, and I saw in the south-east a brilliant meteor. When first perceived (G.M.T. 5h. 32m.), it was about 2° below γ Arietis, it passed over η and vanished close to δ Piscium, leaving a track 7° or 8° long.; the whole did not exceed two seconds. It appeared about twice as brilliant as Jupiter, showing prismatic colours, in which, however, red and blue seemed to predominate. From the distinct sound it produced, and perhaps, also, from its colours, I can but infer, not only that it must have been within our atmosphere, but at no great distance from the earth. I should be glad to hear that in other parts of the country this beautiful phenomenon has been observed, and its position ascertained, that its real altitude may be calculated."

The Great Meteor of the 5th December seems to have exploded at a considerable height above the clouds. Mr. A. S. Herschel states that the same appearances were noticed at Hastings as at Inverness and in Lancashire. He adds:—"It is evident that it closely pursued the path of its predecessor on the 8th of December, 1861. That fireball passed from 110 miles above the neighbourhood of Hull to 45 miles above the Irish Sea, between Lancaster and Douglas, in the Isle of Man. It far exceeded the recent fireball in brilliancy, and was followed, upon the valley of the Lune, by a loud, prolonged report. The second visitation of the same

district by a large meteor is probably an accidental circumstance, but the date from the 5th to the 8th of December may be looked upon as favourable to the appearance of fireballs of large size in every geographical position." Mr. Williams, the Under-sheriff of Beaumaris, confirms the account given of the "hissing sound" of the meteor. "Many," he says, "would have taken the meteor for a rocket, for its marvellous brilliancy, which lighted up the streets like a full moon."—*Times*, December 19.

LITERARY NOTICES.

Observational Astronomy, and Companion to the Telescope: Edited by J. T. Slugg.* *The Stars and the Telescope*: By J. T. Slugg. Although these somewhat unpretending little works are to be procured at a low price, and are given forth by one who is professedly a maker of cheap telescopes, there is more in them than at first might be imagined—and we feel sure that the amateur who invests in them the few shillings required for their purchase will not regret the expenditure. The first contains a very concise catalogue of the principal double stars and nebulæ, with maps to point out their places, while the latter is just the little book to put in one's pocket when wishing to give an "amateur" lecture to a circle of friends. It contains all the necessary information, with an appendix giving the more recent discoveries.

Principal Leitch's little book, entitled *God's Glory in the Heavens*, is an excellent and popular account of modern Astronomy, and the author's breadth of views and felicitous analogies make it very pleasant and profitable reading.

A third edition of *Hind's Introduction to Astronomy*,† with his *Astronomical Vocabulary*, has just been published. It is a clearly written work for the beginner, and not without interest to the more advanced student, who is glad to know the opinion of the writer on some still controverted points. It contains probably the completest table of the minor planets yet published.

Mr. Hind's excellent little work on the *Solar System* has long been out of print. May we beg for a new edition of it, and a companion work on the *Stars and Nebulæ*, as contemplated twelve years ago by the author? It is to be regretted that a treatise so full, compressed and accurate as the *Solar System* should be out of circulation. Such a shilling's-worth of astronomical information perhaps never appeared before or since.

* Simpkin, Marshall & Co. † Bohn.

SUGGESTIONS AND ENQUIRIES.

Is not a *Comet Seeker*, with a rough and inexpensive equatorial mounting, a desideratum? A glass of rather large aperture and low power, with small circles divided to degrees only, might be a useful instrument to amateurs. Or, does an ordinary night-glass sufficiently combine the requisites of short focal length, large aperture, and plenty of light, with enough magnifying power? Should the power be about 12 or 15? I rather think M. Pons, who was a great discoverer of comets, used some such hand-telescope for looking for them. I have used a large binocular for following a comet from night to night, when rather faint, and found it very useful; but the power is too low for general purposes as a sweeper. G. J. W.

Can the monthly notices of the Royal Astronomical Society be bought monthly, as published? They are comparatively of little use, when the volume is published six months or so later. G. J. J.

Does Mr. Main's recent work on *Practical and Spherical Astronomy* contain matter not found in "Loomis's" book, so as to make it desirable to possess both works? G. J. W.

THE PLANETS FOR JANUARY.

Mercury may be seen in the evenings at the beginning of the month, setting about a quarter past five; it arrives at its greatest elongation on the 9th, and is in inferior conjunction with the Sun on the 25th. On the 31st it rises at a quarter before seven. The planet passes from Capricornus into Sagittarius at the beginning of the month.

1st.	R. A.	19 58 46	Decl. S.	22 33	Diameter	5″·8
31st.	„	19 55 43	„	17 17	„	9″·4

Venus continues to be a first-rate object for the transit instrument in the mornings, passing the Meridian about nine o'clock during the month. The planet passes from Libra to Sagittarius, and is a very conspicuous object before day-break, rising about a quarter past four at the beginning, and a quarter past five at the end of the month.

1st.	R. A.	15 33 29	Decl. S.	16 16½	Diameter	19″·2
31st.	„	17 59 46	„	21 43	„	15″·4

Illuminated portion of the disc of Venus, 0·666.

Jupiter rises at four in the morning on the 1st, and about half-past two on the last day of January, remaining in the constellation Libr.

1st.	R. A.	15 13 17	Decl. S.	16 56	Diameter	30″·0
31st.	„	15 31 34	„	18 1½	„	33″·4

Saturn is now getting into a more favourable position for observation, rising about half an hour after midnight on the 1st, and about eleven o'clock at the end of the month. It remains in the constellation Virgo.

1st.	R. A.	13 8 10	Decl. S.	4 37½	Diameter	15″·6
31st.	„	13 10 33	„	4 43	„	16″·4

Dimensions of ring—Outer major axis = 40″. Outer minor axis 8″.

Uranus continues to be favourably situated for observation in the evenings, setting about seven o'clock at the beginning, and four o'clock at the end of the month. It continues in the constellation Taurus.

1st.	R. A.	5 26 49	Decl. N.	23 22½	Diameter	4″·2
29th.	„	5 22 44	„	23 19½	„	4″·0

Neptune may be seen in the evenings, passing the Meridian about half past five at the beginning, and about a quarter to four at the end of the month.

1st.	R. A.	0 14 47	Decl. N.	0 1
29th.	„	0 16 34	„	0 13½.

THE MINOR PLANETS.

The following are the Minor Planets which will be on, or within one hour of Right Ascension on either side of, the Meridian, between nine and twelve o'clock during the evenings of January. Their places are to be found in the supplement to the *Nautical Almanac* for 1867.

	Magnitude.		Magnitude.
Vesta	7·5	Aglaia	11·7
Hebe	8·1	Pales	9.8
Hygeia	10·5	Pandora	10.7
Parthenope	9·9	Concordia	11.7
Egeria	9·5	Ausonia	10·6
Melpomene	9·0	Leto	10·4
Pomona	10·7	Panopea	12·1
Leucothea	13·2	Niobe	11.0
Lætitia	9·5	Feronia	—
Daphne	12·5	Eurydice	—

ASTRONOMICAL OCCURRENCES FOR JANUARY, 1864.

DATE.		Principal Occurrences.		Jupiter's Satellites.		Meridian Passage.
		h. m.			h. m. s.	h. m. Uranus.
Fri	1	 19 39	Sidereal Time at Mean Noon, 18 41 36·9 ☾ Moon's Last Quarter			10 43·4
Sat	2	12 6 16 40 16 54	Conjunction of Moon and Saturn, 5° 59′ N. Occultation of ι Virginis (5) Reappearance of ditto.			10 39·3
Sun	3		Uranus at Meridian Passage } R. A. 2 h. 26·4 m.; Decl. + 23° 22½′	3rd Sh. E. 2nd Ec. D. 3rd Tr. I. 1st Sh. I.	16 23 17 42 15 18 11 19 22	10 35·2
Mon	4	22 2	Conjunction of Moon and Jupiter, 1° 31′ N.	1st Ec. D. " Oc. R.	16 36 24 19 45	10 31·1
Tues	5	13 55 18 4	Conjunction of Moon and Venus, 2° 28′ N. Occultation reappearance of B. A. C. 5395 (6)	1st Sh. E. 2nd Tr. E. 1st Tr. E.	16 2 16 28 17 2	10 27·0
Wed	6	13 29	Conjunction of Moon and Mars, 1° 45′ S.			10 22·9
Thur	7					10 18·8
Fri	8	19 46 21 12	● New Moon Greatest Easterly Elongation of Mercury, 19° 3′			10 14·7
Sat	9					10 10·6
Sun	10	6 11	Conjunction of Moon and Mercury, 5° 31′ S.	3rd Sh. I.	18 11	10 6 5
Mon	11			1st Ec. D.	18 29 59	10 2·4
Tues	12			1st Sh. I. " Tr. I. 2nd Tr. I. " Sh. E. 1st Sh. E. " Tr. E. 2nd Tr. E	15 43 16 47 16 53 17 7 17 55 18 59 19 13	9 58·3
						Moon.
Wed	13	4 46	Near approach of Moon to 16 Piscium (6)	1st Oc. R.	16 13	3 59·2
Thur	14					4 49·8
Fri	15	11 6 12 8 12 44	Moon's First Quarter Occultation of π Piscium (6) Reappearance of ditto			5 39·7
Sat	16		Sidereal Time at Mean Noon 19 40 45·3			6 29·6
Sun	17					7 19·7

DATE.		Principal Occurrences.		Jupiter's Satellites.		Meridian Passage.
		h. m.			h. m. s.	h. m. Moon —
Mon	18	8 54	Near approach of Moon to ω^1 Tauri (6)			8 10·0
Tues	19	12 2 12 38 22 31	Occultation of *l* Tauri (5½) Reappearance of ditto Conjunction of Moon and Uranus 2° 21′ N.	2nd Sh. I. 1st Sh. I. „ Tr. I. 2nd Tr. I. „ Sh. E. 1st Sh. E.	17 22 17 36 18 44 19 36 19 43 19 48	9 0·4
Wed	20	7 57 9 13 13 51 14 53 14 18 17 42	Occultation of χ^1 Orionis (4½) Reappearance of ditto Occultation of χ^4 Orionis (5) Reappearance of ditto Near approach of Moon to χ^3 Orionis (5) Occultation disappearance of 68 Orionis (6)	1st Oc. R.	18 10	9 50·2
Thur	21	17 46	Conjunction of Venus and ξ Ophiuchi, 0° 9′ S.	1st Tr. E. 2nd Oc. R. 3rd Oc. D. „ Oc. R.	15 24 16 37 16 54 18 55	10 38·9
Fri	22	10 2 21 36	☉ Full Moon Conjunction of Venus and ξ Ophiuchi, 5m·7 W.			11 26·1
Sat	23					12 11·6
						Uranus. —
Sun	24	6 30 7 15 9 36 15 58 19 53 20 29	Occultation of κ Cancri (5) Reappearance of ditto Conjunction of Mars and 4 Sagittarii, 1m·4 E. Inferior conjunction of Mercury Near approach of Moon to ω Leonis (6) Conjunction of Mars and 4 Sagittarii 0° 1′ N.			9 9·5
Mon	25	15 15 16 27	Occultation of 14 Sextantis (6) Reappearance of ditto			9 5·4
Tues	26	16 7 17 4 18 14 19 19	Occult. of B. A. C. 3726 (6) Reappearance of ditto Occultation of 55 Leonis (6) Reappearance of ditto	1st Sh. I.	19 29	9 1·4
Wed	27			1st Ec. D.	16 45 29	8 57·3
Thur	28			2nd Ec. D. 1st Tr. I. „ Sh. E. 3rd Ec. D. 2nd Ec. R. „ Oc. D. 1st Tr. E. 3rd Ec. R. 2nd Oc. R.	14 37 30 15 8 16 9 16 17 24 16 52 25 16 57 17 20 18 11 13 19 15	8 53·3
Fri	29	20 6	Conjunction of Moon and Saturn, 5° 49′ N.	1st Oc. R.	14 35	8 49·2
Sat	30					8 45·2
Sun	31	12 17	☾ Moon's Last Quarter			8 41·1

TABLE OF NEBULÆ.

Right Ascension, Four Hours.

NAME OF NEBULA.	Right Ascension.	Declination.
60 Hersc. vii. Persei......	4 0 0	+49 8½
A faint nebulous glow round some minute stars.		
69 Hersc. iv. Tauri	4 0 40	+30 24½
A small star of blurred aspect from surrounding nebula.		
26 Hersc. iv. Eridani ...	4 8 0	−13 5
A curious planetary nebula: the light of its disc brighter towards the centre.		
217 Hersc. i. Aurigæ ...	4 21 20	+34 58½
Excessively faint: practically invisible.		

The nebulæ in the 4th Hour of Right Ascension are neither numerous nor interesting. 26 Hersc. IV. Eridani is curious, and shows more sign of central condensation than do the majority of planetary nebulæ. At 4h. 14m. 5s. of Right Ascension and 19° 12′ of North Declination (1865) is Hind's "Variable Nebula;" but it is quite beyond the reach of such instruments as are likely to be employed in the examination of the objects in our Table.

ON THE BRIGHT STAR "RIGEL."

This very splendid star is favourably situated for observation during the present month, and affords to amateurs an excellent test of the defining power of their telescopes. Its position is as follows:—

1865 = R. A. 5h. 8m. 1s. Decl. S 8° 21½′.

It is a well-known star, β Orionis, and is situated in the right foot of the constellation. The large star is a brilliant first-magnitude. Sir William Herschel describes it as white; Smyth calls it pale yellow. But it is not with this blaze of light we have to do—excepting that it has the effect of overpowering and rendering difficult of observation the little companion star: this is of the 9th magnitude, and is to be found, in an inverting telescope, a little above and to the left-hand of its brilliant primary. The colour of the little star appears now to be blue—Smyth and Webb say sapphire blue; but Sir William Herschel, when he observed it with his 20-foot reflector, set it down as *inclining to red;* his words are:—"The small star near Rigel, for instance, appears of a beautiful pale red colour." Dr. Kitchener, who was an indefatigable gazer at telescope tests, agrees with Herschel as to this, and says the dusky-red colour "was more evident in my 7-ft. Newtonian than in my 5-ft. achromatic;" and also states that the

colour of stars of this character seems to increase in tone as the aperture of the instrument increases, and to be of deeper tone with reflecting than with refracting telescopes.

In the observations on double stars by Sir John Herschel and Sir James South, 1825, Rigel is described as "extremely unequal; large star *white*, small *bluish;* 1st and 10th magnitudes." To the writer of this the small star appears *bluish-grey* (1863). Is this an instance of change of colour since the time of Sir William Herschel?

The distance of the small star from Rigel is now about $9\frac{1}{2}''$, and has increased since the time of Herschel, when he gave it at $6\frac{1}{2}''$. This no doubt will account for the greater ease with which it is now, in many cases, to be seen, the Rev. W. R. Dawes having observed it with a two-foot telescope, and aperture of $1\frac{8}{10}$ inches. Few, however, possess such an eye as Mr. Dawes, and it is a good telescope of 2 inches aperture that will show this object. Admiral Smyth does not include it among the objects seen with the Hartwell telescope—aperture reduced to 2 inches—although it is to be done with that aperture. The writer of this saw it on the evening of Christmas-day this year (1863), with an object-glass by Dallmeyer, of $3\frac{3}{8}$ reduced to 2 inches; but it was rather difficult. Dr. Kitchener states that he saw it well on October 24, 1807, with a telescope of 27 inches focus, and $2\frac{1}{4}$ inches aperture—the only one of the aperture he had met with in thirty years which would show this object; and adds that many of 44-in. focus and $2\frac{3}{4}$ aperture would not do it. The angle of position of the small star with regard to Rigel is as near as possible 200°. Sir Wm. Herschel gave it at 201°·4. Admiral Smyth gives it 199°·4. The decrease in angle being, therefore, only 2° in sixty years, supposing that the observations are perfectly accurate, which, with so very troublesome an object, is scarcely to be expected. In observing Rigel and other bright stars a little reduction of the object-glass may be tried with advantage—a set of cardboard discs, perforated with different apertures, should be used, of such a size as to fit easily within the dew cap; the disc with the largest aperture ought first to be applied, and then smaller ones, until the little star can only just be seen. It will generally be found that the light and rays of the large star are much subdued by adopting this plan.

KAPPA CANCRI.—The last number of the *Monthly Notices,* published on the 16th December, contains the same communication from Mr. C. Leeson Prince that appeared in the *Register* for November, stating that the disappearance of this star at its occultation on the 26th April was *not* instantaneous by fully half a second. The Astronomer Royal also communicates an observation by Mr. Creswick, that the star did not seem to disappear with the suddenness he had generally noticed—that there was a loss of light one-tenth of a second before disappearance. It would almost seem that the size of the object-glasses employed had something to do with the anomaly, the slower disappearance being observed with the larger instruments. Kappa Cancri will again be occulted on the 24th January, but not favourably for observation.

The Dark Side of Venus.—Mr. Prince also communicates observations of this singular phenomenon, which he perceived up to the 6th October: from letters in our last and present number it will be seen that it was observed on the 22nd and 25th. The fact of this appearance is now sufficiently authenticated; it remains that a good explanation of it should be given.

NOTICES TO CORRESPONDENTS.

G. W. W.—The supplement to the *Nautical Almanac* for 1867 may be procured from the *Nautical Almanac* office (Verulam-buildings, Gray's-inn), by purchasers of the almanac for 1864. It is not sold separately.

In our next number we shall give a drawing and description of an *Equatoreal Stand* of convenient and inexpensive construction, by P. Vallance, Esq.

The Astronomical Register.—A Title Page and Index for the Volume for 1863 are in preparation, and will shortly be sent to subscribers.

Some *errors having occurred* in the transmission of the *Register* during the past year, it is particularly requested that those subscribers who have given their names to the Editor will forward their subscriptions to him at Clapton; while those who have subscribed for the Paper with Mr. Potter, will send their payments to 31 Poultry. N.B.—The *Register* is forwarded from the Editor in covers of the same colour as the wrappers.

CONTENTS.

The Astronomical Register.

No. 14. FEBRUARY. 1864.

ON THE PHYSICAL CONSTITUTION AND INTERIOR HEAT OF THE SUN.

By E. W. Brayley, F.R.S.

The following is the syllabus of a lecture which I have engaged to deliver before the "Stoke-Newington Mutual Instruction Society:"—

Spherical Figure of the Sun.—Exact and Unbroken Circularity of its Disc, or of the *Visible Sun*, although the Sun, in all probability, is greatly rougher than the Earth.—This effect probably attributable to the peculiar Constitution, and resulting Refraction, of the Sun's Atmosphere, as recently shown by the Rev. Professor Challis, of Cambridge.—Nature of the Irregularities which, nevertheless, are occasionally observed on the Margin of the Disc.—Instruction derivable from them relative to the Constitution of the Sun.

Inquiry respecting the probable nature of the objects forming part of the Sun's surface, discovered by Mr. James Nasmyth, also observed by other telescopists, and termed by him, from their form, *Willow Leaves*.—Indications that they are probably incandescent and flaming solid bodies.

Nature, changes, and motions of the Sun-spots.—Their analogy to the Cyclones or Revolving Storms of the Earth's Atmosphere, recognised by Sir John F. W. Herschel, and that of the currents in which they drift, as observed by Mr. Carrington, to our Trade Winds; an analogy also first recognised by Sir John Herschel.

Inference from these analogies that the particular surface in the Sun from which the actions producing currents and sun-spots arise, is higher in temperature than any regions exterior to it.—The visible *blackness* of the nucleus or body of the Sun, as seen through the spots, not inconsistent with this inference, but, when strictly examined, conformable to it, and probably, indeed, evidence of its truth.—The distribution of heat in the Sun apparently in the order of decreasing intensity from within to without.

Potential and actual temperatures of the Sun.—Their transcendence of all terrestrial temperatures: the fact probably being that, where the latter terminate in the ascending scale of heat, solar temperatures begin.—Researches of Mr. Waterston and of Professor W. Allen Miller.

Final probable conclusion, from all that is known of the Sun, that it consists of a central body or nucleus, of unknown constitution and unknown intensity of heat or potential temperature, surrounded by three or possibly more concentric spherical envelopes or shells, also of unknown constitution: but these shells are related in their nature to the liquid and gaseous states of matter, and in the outermost, and perhaps in others, solid matter also appears to be continually produced, dissolved, and reproduced: this outermost visible region of the Sun, called the *Photosphere*, is the immediate source of its radiation of Heat, Light, and Chemical Action: all these spherical envelopes float or are suspended, one within another, in an aëriform atmosphere of imperfect transparency, which rests on the nucleus; and on which again may be based a more transparent and rare atmosphere, in which the solar clouds, seen only at total eclipses in the form of "Luminous Prominences," are themselves supported.—Differences of opinion among astronomers as to the equilibrium and position among the structural elements of the Sun of the solar atmosphere or atmospheres.—Relations of this part of the subject to the existence in the Sun of the vapours of known metals, believed to be established by Prismatic Analysis.—If that belief be well-founded, the incandescent surface of the Photosphere supplies the continuous radiation required by Professor Kirchhoff's theory of the dark lines in the solar spectrum.

As this syllabus contains indications of certain new views respecting the Sun, which my present occupations will not permit me, for want of time, to state in a more particular manner, I am desirous that they should be recorded in your pages; intending, before long, to enunciate the views themselves in some detail, together with the observed facts on which they are founded.

The syllabus may be regarded as an appendix to a paper which I have contributed to Knight's *Companion to the Almanac* for 1864, pp. 18-52, giving an account of the "*Recent Observations and Researches*" of astronomers and physicists "*on the Physical Constitution of the Sun*," with inferences from their results, in which some of the new views alluded to are involved. In the rapid progress of science fresh researches have been accomplished or described, more observations made, and novel views taken of the phenomena of the Sun, even in the short period which has elapsed since the printing of that paper; and others, with which I was previously unacquainted, have come to my knowledge.

When the paper was written, I had inferred from various observations that solid matter must exist in the photosphere, if not in lower regions of the sun (*Comp. to Alman.* pp. 25–36), and that all the spherical shells which surround the nucleus must be in unceasing and universal molecular activity, and, like the crust of the Earth (itself a spheroidal shell), in process of continual production, dissipation, and reproduction. But from a better acquaintance with the discovery of Mr. Nasmyth, from Sir J. F. W. Herschel's interpretation of the nature of the *Willow Leaves* (*Good Words*, April 1863, p. 282), and the further consideration of the entire subject, I have since been led

to conclude, that in the photosphere, and perhaps in the interior regions between it and the nucleus, *solid matter* must be continually produced, dissolved, or fused, and reproduced by refrigeration, as now intimated in the syllabus. Another conclusion, in harmony with the foregoing, and also with previous well-known inductions, is, that mainly from this solid matter, and the liquid from which it is congealed, as forming together the incandescent surface of the sun, its radiation of heat and light to the planets must proceed. That surface, however, it has appeared to me, must, notwithstanding, be lower in temperature than any region within it, though itself transcending in heat all terrestrial temperatures to an unknown degree.

In noticing Professor Kirchhoff's researches, and his theory of the constitution of the sun and nature of the spots, I had remarked (*Comp. to Alman.* p. 40), "The existence of known terrestrial metals in the gaseous state in the Sun's atmosphere, even if regarded to be fully established, affords no reason whatever for believing the spots to be clouds. These two subjects are independent of each other. The chemical composition of the solar atmosphere may be that assigned to it by Kirchhoff, and the combined processes of radiation and absorption by which it is manifested in the fixed lines of the spectrum may be such as he conceives, and yet the physical constitution of the sun and the particular nature of the spots may be, notwithstanding, those which Wilson and Bode, and Dr. Herschel, inferred from actual telescopic observation, and which have been adopted substantially by Sir J. Herschel and the most accomplished and philosophical astronomers of the present day, who, regarding them to be confirmed by their own observations, have made them the basis of their own more fully developed theory of the Sun."

The scope of the article did not require further explanation on this head, and I reserved the subject of *Solar Chemistry*, among others, for a subsequent contribution, in which I intend to show that, as also intimated in the syllabus, while the incandescent surface of the photosphere would supply the continuous radiation required by Kirchhoff's theory of the dark lines in the solar spectrum, the known atmosphere of the sun would exert the absorptive action also required, without our being called upon, by the acceptance of that theory, to ignore or nullify, as the Heidelberg professor appears to do, all the observations and results of modern astronomy on the actual structure of the great centre of our system.

London Institution, Jan. 11, 1861.

[Since going to press, Mr. Brayley has forwarded to us some further remarks on this subject, which will appear in our next number.—Ed.]

ROYAL ASTRONOMICAL SOCIETY.

Third Meeting, January 8th, 1864.

Warren De la Rue, Esq., *Vice-President*, in the Chair.

Secretary, Mr. Hodgson.

A number of presents, including the usual serials, were announced.

D. J. Kennerley, Esq.,
Alex. Freeman, Esq.,
J. W. Mulcaster, Esq.,
Alfred Brothers, Esq.,
Lieut. A. W. Stiffe,
F. Smith, Esq.,
G. T. Sadler, Esq.,
E. G. Henessey, Esq.,
The Rev. W. A. Darby, and
W. M. Dobie, Esq., M.D.,

were ballotted for, and duly elected Fellows of the Society.

A paper by Professor Challis, "*on the Calculation of an Optical Effect of Refraction*," was read by Mr. Hodgson. It was partly in answer to some remarks by the Astronomer Royal at the last meeting, in reference to a brightness on the limb of the moon seen in partial eclipses of the sun.

Mr. De la Rue did not agree with Professor Challis, and considered that the effect of a bright band on the moon's limb was entirely due to contrast. A similar white line was seen in a photograph of the dome of St. Paul's Cathedral; and although this appearance might mathematically be perfectly right according to Professor Challis, yet practically it could be proved to be due to the effect of contrast alone.

Mr. Carrington made some remarks on the volume (just completed by himself) of "*Observations on Solar Phenomena.*" Its contents were, in the first place—Introductory matter: an explanation of the method of proceeding, and a history of the subject. Secondly—Tables: giving a catalogue of concluded positions of the solar spots, with discussions of these positions. Thirdly—Discussions of the movement of the spots, in order to discover their drift on the body of the sun. Fourthly—Whether the elements of the poles, &c., could be improved upon. The work had cost upwards of three thousand pounds, although carried out with the greatest regard to economy; and Mr. Carrington believed that no further improvement in the elements could be made, unless at least five thousand pounds were expended for the purpose. The object of the work was to place on record a method, which it was hoped might be followed, of treating the subject as a matter of observation.

A paper by Mr. Hind, "*on the Variable Nebula, or Nebulous Star, in Taurus,*" was then read.

"*On the Willow Leaves, so-called, seen on the Solar Disc*," by Mr. Nasmyth. To observe these appearances, a telescope of power must be employed, in a tranquil state of the atmosphere, and it will be found that the entire luminous surface of the sun is formed of *willow-leaf shaped* objects, their average length being about one thousand miles and their width about one hundred. The mottled appearance is caused by great numbers of these willow leaves crossing each other. Mr. Nasmyth had no desire to embark in any controversy on the subject, but preferred to refer to the sun itself for a confirmation of what he considered himself to have discovered—the *willow-leaved* character of these appearances in the sun. He had in hand a 12-inch glass reflector, which he proposed to use without a tube for observing the sun's disc, as he considered the tube to interfere with definition.

Further remarks on the "*Telescopic Appearance of the Envelope of the Sun and of its Spots.*"

The *pores* mentioned in the former part of this paper are seldom *round*—often rather like small *fissures*. Their visibility seems to vary greatly at different times, even under apparently similar circumstances. The *less* luminous masses of the photosphere, in which alone they are found, appear to vary considerably in the area they occupy, compared with that of the *most* luminous masses; and at the present it seems to be the greater of the two. This variation must produce some corresponding change in the quantity of solar light, and may place our sun among the slightly variable stars. It may be reasonably expected that photography might help us in this matter. The different luminosity of these masses gives at first the impression of an undulating surface, the less luminous being depressed. But this impression is proved to be erroneous by the fact that they are seen to occupy the same comparative space quite up to the edge of the sun at the poles, and at the equator also, except where concealed by *faculæ*. I therefore concluded that the two, though both self-luminous, may so far differ in their nature as not readily to intermingle, and that they do so at all only at their confines; and also that, with the exception of the faculæ, which are composed entirely of the brightest masses, and are certainly elevated, they are very nearly at the same level. The apparent *mottling* of the sun's surface is obviously produced by the juxtaposition of these masses of different luminosity; and this certain and easily recognised fact seems to be quite incompatible with a pretty uniform distribution of luminous masses of any one shape and degree of brightness. In considering the cause and formation of the *spots*, it may be convenient to divide them into two classes—the *profound* and the *superficial*. 1.—The *profound* are those which penetrate the three solar envelopes, and appear to expose the body of the sun itself. They

give the impression of being produced by a violent discharge of some non-inflammable gas from the body of the sun, which, rushing through the first or *cloudy stratum*, causes the perfectly *black hole* seen in the middle of a large and symmetrical spot, and forming its real *nucleus*. The inner edge of this stratum round the nucleus is seen to be of a lighter shade than the rest, and looks heaped up or rolled back upon itself. The evolved gas becomes heated and expanded by approaching the middle or *penumbral* stratum, of which a far larger area is therefore removed by it, thus laying bare the upper surface of the cloudy stratum, and forming the *umbra* of the spot. Being much more heated and expanded by approaching the third stratum or photosphere, the gas throws off a still larger area of this, and leaves exposed the *penumbra* of the spot, on which, however, are seen some remnants of the photosphere in the bright lines projected on it. At the inner edge both of the second and third stratum there is the same appearance of heaping up of the luminous matter, and rolling it back on itself, as was noticed in the cloudy stratum; but this seems to be confined to spots which are recent or enlarging. When they are closing it disappears. The *rotary* motion may be produced by a whirlwind kind of action; but I have observed it with certainty on only two or three occasions, and believe it to be very rare—in the *profound* spots, at least. 2.—The *superficial* spots. They seem to be formed by disturbances in the photosphere itself, or at a small depth below it. Large areas of the penumbral stratum are sometimes laid bare, without any umbra at all. Occasionally there is for months together a tendency to outbreaks of small spots arranged nearly in an elliptic form, in which the penumbra is uniformly thrown outwards from the centre.

In a P.S. are given some extracts from a paper on the sun by Sir W. Herschel, contained in vol. xci. of the *Philos. Trans.* They were lately communicated to Mr. Dawes by Mr. Birt.

Mr. De la Rue, while confirming the statements of Mr. Dawes as to the appearance of the surface of the sun, must yet repeat that he had seen the "spindle-shaped" figures on the disc, but they were not always to be observed.

Mr. Carrington said that the observations now most wanted were from one quarter of an hour to another: we want the sun to be kept under constant observation. A glass speculum, an observant eye, and sagacious mind were required. If he (Mr. Carrington) had his way, he would set Dr. C. F. Peters to work, whom he would like to see provided with good instruments for the purpose.

Mr. Hodgson would propose that an intelligent sapper, who would be quite unprejudiced, should be put on, who, with his military discipline, would commence at six in the morning, and work continuously at a small cost.

Mr. Carrington replied, adverting to a little tract, *Eyes and No Eyes*, and said that he considered that uneducated persons were most given to prejudice.

Mr. Brayley, alluding to a new interpretation of solar phenomena he had recently made public,* in which the heat of the sun is considered to be most intense in its central regions, contrary to the prevalent belief of astronomers, remarked that the phenomena of the spots attributed by Mr. Dawes, in the paper which had been read, to the augmenting expansion of incombustible vapours rising from the nucleus through regions supposed to increase in temperature successively to the photosphere, where it was supposed to be highest, did not militate against the view he had taken of the distribution of heat in the sun, even admitting them to be due to that expansion. If the eruptions to which Mr. Dawes had thus referred the production of the spots and their increasing magnitude from below upwards, were really comparable to those of volcanoes, as conceived by him, the vapours must issue from the nucleus at an intensely high temperature, but also enormously condensed, and they would therefore expand as they rose through the exterior regions of the sun, until the equilibrium of heat and tension was attained, independently of the temperatures proper to the regions at which they might successively arrive. Mr. Brayley also briefly explained his view that the willow leaves of Mr. Nasmyth, which he conceived to be identical with the striations resembling coarse thatching with straw observed by Mr. Dawes, and the luminous bridges of M. Chaconnac, were flaming solid bodies produced by the *freezing* of the surface of the photosphere, resulting from its loss of heat by radiation, into a colloid or crystalline solid pellicle, which, however, perpetually broke up all over into these shivers, through the turbulent action beneath, its integrity not being maintained even momentarily, but being continually renewed by solidification, only to be broken up again, and so on in continual succession; and further, that the solid matter thus produced (being of the nature of those substances which contract when they solidify, and so become heavier than when in the fluid state) sinks in the fluid matter below, which rises to take its place and become in its own turn solidified. A resultant condition of mingled solidity and liquidity would thus be attained in the superficial zones of the photosphere, whence the sun's radiation of light and heat proceeds. He concluded by showing the application of these views to Kirchhoff's theory of the fixed lines of the spectrum; but as he has noticed that subject in the article already referred to, we need not repeat it here.

* In the *Companion to the Almanac* for 1864. See also the first article of the present number.

Colonel Strange described an invention arranged to diminish personal error in right ascensions during meridianal observations, by M. Redier, of Paris. There was one fixed wire in the meridian; another parallel moveable wire (with which the eye-piece moves) was carried along by a small chronometer at the same rate as the star. The effect was, that owing to the movement of the eye-piece, the star and moveable wire appeared to be stationary in the field of the telescope, and the contacts could be taken in the most accurate manner by observing the index on the dial of the small chronometer.

Mr. De la Rue recalled to the recollection of the Society a somewhat similar method proposed by Professor Wheatstone.

Professor Sellwyn directed attention to the fact that the solar spots occurred not on, but north and south of the sun's equator, and considered that there might be some analogy between this fact and the occurrence of storms in the tropical regions of the earth. The matter, or gas, as shown by Mr. Dawes, was heaped up at the edge of the penumbra; and this was the case with these tropical storms or cyclones, in which sailors found the barometer lowest in the centre and highest at the edge of the storm. There was an analogy, also, between the rotatory motion of the spots and the storms alluded to.

Professor Adams could not admit the analogy between the rotatory motion of the solar spots and the tropical storms on the earth. As the sun gives out heat, while the earth receives it, the action upon each is quite different. The heating power of the sun acts differently upon the earth in different latitudes, and the transference of air from one latitude to another produces relative and apparent rotatory motion; but Mr. Adams could not understand the analogy between that and any action on the surface of the sun which does not receive heat from an external body. Radiating heat in all directions, the sun can have no trade winds similar to those on the earth; and though not denying the result of observations, Mr. Adams considered any analogy between the two things to be a false one.

Professor Sellwyn said the analogy was between the apparent phenomena of the sun and the known phenomena of the earth, which is borne out by sailors finding the barometer lower in the centre than at the edge of these storms: that analogy, he thought, was established. Sailors also observed that in the northern hemisphere the storms revolved in a direction contrary to the hands of a watch, and in the opposite direction in the southern hemisphere: let it be observed whether there is any analogy between this and the rotatory motion of the spots on the sun. In his Cape observations, Sir John Herschel enters into the cause of this rotation, and states that if there is anything which produces greater heat at the equator than at the poles, we shall have a flow from the pole to the equator, which

will produce these vorticose motions, and he points out the rotation of the sun causing a thicker gaseous envelope round its equator as an adequate cause. Without entering further on this subject, there seems to be good reason for making further observations.

Mr. Hodgson said, he had never detected any rotation of the spots: he thought if there had been, it would have been shown by the photographs taken of the sun; but the pictures were too small to be of service, and he wished that photographers would give larger views of the spots.

Mr. De la Rue said that large views had already been given by photography, nevertheless he intended to enlarge some of the pictures of the smaller spots in question; adding that the discussion proved, as Mr. Carrington said, that the sun ought to be observed, not only day by day, but hour by hour, and by experienced observers, but it was a matter requiring much expense and pre-arrangement.

After a few observations by Mr. Drach, who adverted to the fact that the progress of a spot had been frequently observed from commencement to complete maturity, and considered that their movements might be influenced by the rotation of the sun, the meeting adjourned.

THE NEBULA IN THE PLEIADES.

As the beautiful cluster of the Pleiades forms one of the ornaments of our winter sky, some particulars of a nebula situated among its stars, and to which a great amount of interest attaches on account of its suspected variability, may not be unacceptable to our readers. We therefore condense from the Rev. T. W. Webb's paper in the *Intellectual Observer* for January the following notes on the subject, referring to the original those who require further detail. The nebula in question was discovered by Tempel, at Venice, in October, 1859. It was then large and bright, and easily seen with a small instrument. It is close to the star Merope, 23 Pleiadum, which, excepting Alcyone, is as bright as any in the cluster. In December, 1860, it was only visible at Altona in a 6-foot telescope; and by August, 1862, it could not be found at Copenhagen with 11 inches of aperture on the finest nights. Schmidt of Athens states that he has attentively observed the Pleiades from 1841, and drawn them repeatedly from 1844 and 1861, but he never saw the nebula till 1861, when he found it making Merope look like a nebulous star with 7½ inches aperture, and in March, 1862, it was easily visible. These observations would certainly tend

to show that nebulæ, like stars, may be variable in brightness; but the difficulties of such a supposition are very great as long as we consider the nebulæ to be always composed of stars. Such an hypothesis seems to involve a simultaneous fading and brightening of myriads of stars, which can hardly be conceived probable, although a difference of intensity in really nebulous or cometic matter is not so difficult to understand. There are, accordingly, several observers who attribute the failure to see the nebula in the Pleiades with large telescopes to the nature of the object, and its want of intensity when the light is diffused by magnifying. Hence it is more readily seen in a small glass. On this side of the question we may quote Schonfeld, of Manheim, who saw it as well in 1862 as in 1860; and Auwers, of Gottingen, saw it repeatedly during 1860, 1861, and 1862, with a comet-seeker of 2 feet focus and less than 2 inches aperture. He thinks the failure of D'Arrest at Copenhagen, and others, to see it about the latter time, arose from its size and diffusion filling the field of the large glass, while it was more condensed in the smaller instrument. This is corroborated by the Pulkowa observations of 1862, when the large 15-inch refractor only showed its existence as a cloudiness when the instrument was moved to and fro, while a 4-inch telescope rendered it easily visible. At present it would appear to be readily seen. Mr. Webb—who, we believe, uses a 5-inch aperture—found it on October 6th, 1863, and again on November 10th, adjoining to and enveloping Merope, and extending about 17′ to the south; and we have since heard that it has been perceived on an unfavourable night with 3 inches of aperture; so that the possessors of moderate telescopes may look for it with every chance of success, and the record of their observations cannot but be useful. The nebula of which we have been speaking must not be confounded with the one known as the missing nebula in Taurus. This latter is nearer Aldebaran, and was discovered by Hind in 1852. For some time it grew brighter, but subsequently became invisible in the largest telescopes, the great Pulkowa refractor being the only one which gave a suspicion of its existence in 1862.

T. W. B.

AN INEXPENSIVE EQUATORIAL STAND.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—As some of your readers may consider an equatorial stand a rather expensive luxury, and, in consequence, put up with a much less convenient form of mounting, I will describe one I contrived about two years ago, and

which I have had in use ever since, with perfect satisfaction as to steadiness and general convenience. It can be made by any amateur who can handle a saw and screw-driver for a few shillings, and he may have the luxury of a mechanical motion which will keep his telescope upon a star as long as he wishes to look at it.

Should any of your readers wish for more information on this subject than the following description will give them, I shall be happy to reply to any inquiries, or show them the stand I have in use.

I am, Sir, yours, &c.,
PHILIP VALLANCE.

4 Botton Road, Abbey Road,
St. John's Wood,
December 1863.

Three strong legs are necessary for the stand, and these may be most cheaply made by getting a 14-foot length of 2-inch yellow deal, and having cross-cut it in the middle, then sawing each half with a diagonal cut, beginning at 2 inches from the outside of one end and ending at 2 inches of the outside of the other end as in fig. 1. This will make four legs, 7 inches wide at one end, 2 inches wide at the other, and 2 inches thick. There will also be one more leg than is wanted, but as the labour in doing this is but little, I know of no cheaper way of getting three strong legs.

The top of the stand is to be made of beech, 1½-inch thick. Cut a circle of 18 inches diameter, and on the circumference set out three points equidistant, and 3½ inches from these points on each side of them, cut out a piece as in fig. 2; this will leave three projections, 7 inches wide, for the legs to be fixed to. On each of these projections one leg is to be fastened by a large door hinge, at least 6 inches long—having previously cut each leg to the right bevil at the top and bottom, and of the right length in accordance with the length of the telescope to be used. The legs of my stand are 5 feet 7 inches long, and spread 2 feet 6 inches from their common centre; and the length of my telescope is 80 inches, and its aperture 5½ inches. So much for the stand.

The parts to carry the telescope are to be made of iron gas tubing, and are as follow: A two-foot length of 2-inch iron gas tube (called by gas fitters a *short-piece*) is to be cut asunder 8 inches from one end, and 2 two-foot lengths (or short-pieces) of 1½-inch iron gas tube, are to be selected small enough to turn easily inside the 2-inch pieces. This will require a little attention, as all 2-inch tube is not large enough for 1½-inch to turn inside it, but plenty may be got with a little trouble; therefore it is best to get one length of 2-inch and cut it asunder, instead of getting two short pieces of the requisite length. (Each short-piece has a screw on each end, and a socket-piece on one of these screws.)

Two T pieces are next to be got, having an opening to receive the 1½-inch tube at the bottom or middle, and opening to receive the 2-inch tube at the ends or sides; see fig. 3. These will be screwed one on to the end of each of the 1½-inch short-pieces—one to form the polar axis and to carry the tube of the declination axis, and the other to hold the cradle of the telescope, for which it must be cut open lengthways on the top and bent into the shape to fit the cradle as in fig. 4; on this must be riveted a cradle of sheet iron or brass to carry the telescope, as in fig. 5. The 16-inch length of the 2-inch short-pieces, having the socket on its top, is to carry the polar axis, and must be fixed on the top of the stand at an angle of 51½ degrees, or the latitude of the place, with the upper end over the centre of one of the legs of the stand and the lower end between the two others, by two pieces of beech 1½-inch thick, and shaped as in figs. 6 and 7; the last (No. 7) to

stand across the polar axis and over the leg of the stand, and the other (No. 6) lengthways with the polar axis, to support it on the top of the stand. Each of these pieces should be hollowed out to fit the tube that lies upon it, and the tube should be fastened to these pieces, and these pieces to the stand by two pieces of $\frac{3}{8}$ iron wire, bent as in fig. 8, and having screws and nuts on each end, one at the top, over the tube, close under the socket of the 16-inch length, outside the piece No. 7 and down through the top of the stand; and the other near the bottom of the tube, across it and the piece of wood carrying it, down through the top of the stand; and fixed by the nuts and screws.

The tube which carries the polar axis being thus firmly fixed on the stand, one of the lengths of the $1\frac{1}{2}$-inch tube, having the T piece on its top, is to be passed through it; then into this T piece is to be screwed the other length of the 2-inch tube, and through that is to be put the length of the $1\frac{1}{2}$-inch tube on which is screwed the T piece carrying the cradle for the telescope.

You have thus, at the cost of a few shillings, an equatorial stand, perfectly steady, capable of pointing the telescope in every direction, and, if properly placed, of following a star with one motion.

The telescope and cradle, &c., must be balanced by a counterpoise put on the end of the declination axis; and the telescope placed in the cradle with its centre of gravity over the centre of its axis.

The method I have adopted for giving motion to the telescope is as follows: On the polar axis, at the end which is below the stand, and at a right angle to it, I have a lever fixed by a binding screw, which, when tight, carries the polar axis with it, and when loose allows the polar axis to turn without it.

This lever stands out from the polar axis and between the east and west legs of the stand. On the eastern leg I have a pulley, and a line fastened to the lever running through this pulley has a weight on it capable of pulling the telescope after a star that is towards the west. To regulate the speed of the telescope I place a bladder of air between the lever and the leg of the stand, having a tube from it with a stop-cock; of course, the faster the air gets out the faster the telescope moves, and I regulate the speed most readily by putting the end of the cock into a little water, when, as the bubbles of air are heard to come out, the speed can be regulated to the greatest nicety.

Two round discs of wood, having their surfaces hollowed out to something like the curve of the bladder, are placed, one between the lever and the bladder, and the other between the bladder and the leg of the stand, each being attached (the one to the lever and the other to the leg of the stand) by a loose pin in its centre long enough to allow them to press the bladder squarely between them. I make a hole lengthways through the centre of each pin, and a corresponding hole through the centre of the disc of wood and of the lever or leg, and a piece of cord, with a knot at each end, holds the disc of wood so loosely against the bladder as for it to press squarely, although the lever and leg form a constantly-varying angle.

In the tube through which the air passes out of the bladder into the water is an extra stop-cock, to shut off or turn on the air as required, so that the regulating-cock need not be touched after being once adjusted. A second tube also goes into the bladder to blow more air in when it is exhausted.

By this simple contrivance I have kept a star in the field of my telescope for three-quarters of an hour; and it would do so longer but that the discs of wood approach so near that the surface of the bladder is increased, and the speed lessened by that.

By taking a little more trouble, and also going to a little more expense in the getting up of the stand, a very tolerable equatorial may be made

quite capable of pointing the telescope on any star, by the tables, clock, and almanac.

First—In the socket of the 2-inch tubes which carries the polar axis, have a brass bearing, made with a flange, as in fig. 9; and also on the other end of the same 2-inch tube fix a similar flanged socket as in fig. 10. The $1\frac{1}{2}$-inch tube which goes through it must be turned at the parts where it bears on each of the brasses, and also have fixed on it, at each end, another brass-flanged socket, to bear smoothly against the other flanges, as in fig. 11. This will give perfect smoothness to the motion.

And on the other 2-inch tube, which carries the declination axis, fix similar brasses, and turn the $1\frac{1}{2}$-inch tube in the same manner.

For the circles and indices I have made use of old theodolite circles, and have fixed them on discs of mahogany screwed tight on to the flanges of the large tubes; and the indexes to the other flanges carried by the smaller tubes.

The telescope must be set true to the polar axis, and at right angles to the declination axis, by packing in the cradle which carries it.

In conclusion, I may state that I have had a 10-foot refractor with a 7-inch aperture on a stand of this size and construction, which has been perfectly steady and easy in all its movements.

A stand of yet more easy construction may be made by using similar tubing in this manner:—

Fix what is here called the polar axis tube upright on the top of the stand; and the other tubes being placed as before described, a stand of the altitude and azimuth class will be the result, which, by using the tubes rough as they come from the shops, will be easily made, and yet be found steady and convenient,

A clamping screw should be put in each of the 2-inch tubes, which, by pressing on the interior tube, will fix it at any point, or prevent it from turning too easily.

For smaller telescopes smaller tubes may be used. I have one for a $4\frac{1}{4}$-inch, 6-foot focus, made of $1\frac{1}{2}$-inch and 1-inch tubes; and another for a $3\frac{3}{4}$-inch and a 4-foot focus, made with 1-inch and $\frac{3}{4}$-inch tubes.

CORRESPONDENCE.

N.B.—We do not hold ourselves answerable for any opinions expressed by our correspondents.

MOTION OF THE SOLAR SYSTEM IN SPACE.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—I do not know whether your readers can realise a feeling of "delight" that anything which is believed to be true, and as resting on a scientific basis, should be in a "state of confusion." I allude to what took place in the Astronomical Society last month, an account of which is given iu your valuable journal for January. But surely the difficulties and "*delightful* uncertainty" referred to as to parallax are not the only ones affecting the question.

If the sun moves in space, whatever may be the direction, it is evident that the greatest velocity of all the planets revolving round the sun must be greatest at the same radial points where their orbital motions all coincide with the sun's onward path; and their least motion when diametrically opposite. The points of greatest and least motion, therefore, of the earth and planets could only occur at these opposite points, and not, as usually taught, at the differing places of perihelion and aphelion, where, were the sun at rest, their velocities might be greatest and least.

Again—if the sun moves in space, the variation in the orbital velocities of all the bodies that revolve round it *must* differ, by the whole amount of the sun's motion, when at right angles to its path, twice every revolution they make. For instance, taking the sun's motion as 18,000 miles an hour, the earth's mean orbital velocity of 65,000 miles an hour must sometimes be 65,000 + 18,000 = 83,000; and six months afterwards, 65,000 − 18,000 = 47,000 miles an hour only. Is this credible on physical principles? Moreover, if the sun's motion in space were 65,000 miles an hour (Bessel thought it twice or three times as great), then the earth's orbital motion once a year would momentarily cease: as it must then describe a perfect cycloid in going round the sun. Then its velocity once a year would be 65,000 + 65,000 = 130,000 miles an hour; and six months afterwards, 65,000 − 65,000 = 0, according to well-known mechanical principles and the necessities of the laws of space and motion. It is not so plainly obvious, but it is equally true, that if the sun's motion is only 18,000 miles an hour, the earth must yearly pause altogether for an instant, in describing the looped curve it *must* describe in going round the sun. The "loops" would be sharp and pointed, and not round (as usually represented) where the earth and sun's motions were most directly opposed. This is a mere fact of mechanical construction: the earth's path would be what I may call a *compressed cycloid*. But is that credible?

Once more—if the sun moves in space, the base line from which the fixed stars at right angles to the earth's path are viewed, at intervals of a year, is no longer only 182 millions of miles (or 190 millions, taking the radius as = 95 millions), but must be the diameter of the earth's orbit *plus* the sun's path between any two periods of observation, at six months interval. At 18,000 miles an hour, the sun travels 157,680,000 miles a year, upwards of 220 millions of miles every 18 months; and if to this we add 182 millions of miles, the diameter of the earth's orbit, we have 400 millions of miles as the base line between each 18 months; and 220 millions of miles to add to this *for every year* elapsing between parallactic observations. But all these observations have proceeded on the erroneous assumption of a base line of only 190 (or 182) millions of miles, as regards stars in every quarter of the heavens. This creates many a serious and *not* "delightful" addition to "the confusion that exists" on this question.

Is it not more rational (it certainly could not be *less* so) to seek for another explanation of the apparent proper motions of some of the fixed stars?

Allow me to suggest one probable or rather necessary cause of such apparent motions, which will also account for their irregularities as observed from different observatories, and so get us out of the "state of uncertainty" to which the Astronomer Royal referred. It is now a well-known and generally recognised geological fact that upheavals and depressions of the land are taking place continually throughout Europe and the world. It is not at all probable—or rather it would be impossible—that when such upheavals or depressions take place, they can be uniform in different places, or could occur in such directions as not to disturb materially the parallax of stars viewed from such disturbed points. Unless, therefore, we are to

suppose such geological changes have never affected the various observatories in Europe, we can easily see that variations in parallactic observations must be the consequence. If, however, the upheavals and depressions of the land are denied, this suggestion falls to the ground. But even then, I think that reflecting men, who will take the pains to realise definitely some of the simple and inevitable consequences of the sun's motion in space—i.e. if they also believe in the ordinary laws of motion and the elementary principles of mechanics and physics—will not be able for an instant to retain a belief in the motion of the solar system being possible; and they will surely seek for some other explanation of the apparent proper motions ot the fixed stars.

I am, Sir, your obedient Servant,
J. REDDIE.

Hammersmith, Jan. 7, 1864.

SHOOTING STARS.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—While you include notices of new Comets in your excellent Register of astronomical discoveries will it not interest your readers to learn the occurrence of a celestial phenomena equally extraordinary, but more nearly tangible to our restricted sphere of observation? On the 2nd January last, from 11 p.m. to early on the morning of the 3rd inst., a shower of exceedingly bright shooting-stars was seen from the north to the south of England. They appeared in the greatest numbers from 12 p.m. of the 2nd (midnight) to 1½ a.m. of the 3rd inst., when three or even five falling-stars could occasionally be seen almost at the same instant of time; and fifty to sixty could be counted in an hour by a single observer. One brighter than the planets, with a nucleus 2′ or 3′ in diameter and a train of sparks 2° in length, appeared about this time in the zenith of Manchester.

These falling-stars radiated from (c) *Quadrans Muralis* near the head of Bootes; almost horizontally from north to south, brighter than fixed stars of the second or third magnitude, colourless, and leaving streaks of light for a moment behind them. The paths were protracted, with frequent irregularities of light and motion, a quality indicating by itself their horizontal course. A horizontal stream offers remarkable facilities to astronomers for studying the nature and peculiarities of these singular occupants of planetary space. The January stream is most nearly horizontal at a quarter before 9 p.m. on the evening of the 2nd January, and its return may be expected every year with greater or less intensity at the same date.

I am, Sir,
Your obedient Servant,
ALEXR. S. HERSCHEL.

Collingwood, Hawkhurst,
Jan. 9, 1864.

DARKNESS AND LIGHT.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Mr. Editor,—I trust that you and your readers will excuse the raising of an apparently absurd question—one that will strike many readers as non-

sensical, namely, "*How can there be any darkness?*" As an amateur astromomer I have always been under the impression, from the data given by all the writers, that the sun is an enormous globe dispensing light and heat in *every direction* without cessation. This, I believe, is a generally received fact. We therefore picture to ourselves the various orbs which compose our Solar System as floating in a *sea of light.* If so, the rotation of these several bodies upon their respective axes does not, as it seems to me, involve the necessity of their respective surfaces being immersed in darkness, because they are on the side averted from the sun. I acknowledge the existence of *shadow as far as it goes*, but no farther. But I will come to my main point. I want to know *why* it is, if our attendant satellite and the planets of our system all receive their light alone from the sun, that we cannot trace the beams of light passing from the great luminary to these respective bodies? We perceive the beams penetrating our own atmosphere and darting through the clouds. It will be said perhaps that the rays of light are only visible when they touch the respective *atmospheres*; but we are told again that our moon *has no atmosphere.* Don't fancy, Mr. Editor, that I am going to question the theories of Newton, or the system of Copernicus; but I am rather *in a fix* upon this question. It is a singular fact that if the exploded idea of the sun revolving round the earth from east to west were correct, it would give a direct solution of my difficulties.

Yours,

Jan. 1864. READINGENSIS.

THE MOON'S ROTATION.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—Thinking it possible that at least some of the sisters, wives, and daughters of your subscribers may be as much inclined to give their attention to a practical illustration of the above subject, as to eight score lines of Cyclopean verse, I venture to suggest one which any of their number may easily try.

Place an apple in the centre of a table, and on the north side of it place a mariner's compass—one in which the card is attached to the needle, and is suspended with it. In such a position the *south* edge of the card will be presented towards the apple. Now cause the compass to *revolve*, and we shall observe that when it reaches the west side of the table its *eastern* edge will be towards the apple. At the south side of the table its *northern* edge, and at the east side its *western* edge will be presented towards the apple. It is obviously then no dogma that during one complete revolution round the apple every portion of the edge of the card will be once presented towards it. By virtue of the directive power of the magnetic needle, the card does not *rotate*, it is therefore not a dogma to state that this is an illustration of the effects of revolution *without* rotation.

But if the card *did* rotate *once* in the same direction during *one* revolution, the *same* portion of its edge would *always* be turned towards the apple, and if it rotated once in an opposite direction, each portion would be presented towards the apple twice.

This clearly is no dogma either, as

"Any one may ascertain
Who tests it thoroughly again."

I am, Sir,
Obediently yours,

Knightsbridge, S.W. A. L. S.
Jan. 15, 1864.

THE MOON CONTROVERSY.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—As you have permitted Mr. Perigal to bore us again with his crotchets about the moon, I trust you will allow me to ask him a simple question: If he were to walk half round the circumference of a great circle *without* rotating on his axis, would not his face when he got there be turned in precisely the same direction as if he had walked across the circle along the diameter; and therefore would not the same thing happen if he walked round a smaller or larger arc of the circumference, as if he crossed along any corresponding chord?

Surely he must see that if he does the one he must do the other; but if not, let him keep to his lathe-turning, and cease to bother us about the turning of the moon, which is evidently beyond him.

I am, Sir, yours, &c.,

Highgate, Jan. 18. ARGUS.

THE MOON'S AXIAL ROTATION.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—It seems to me that to a body rotating on an axis, every object at a distance must appear to travel round it in circles in a direction opposite to that of its rotation. Now, to a person in the moon the earth would always appear in one direction—in fact, an astronomer with a telescope rigidly fixed so as to point in the direction of the earth would always find that body in the field of view. If he supposed that the moon rotated on its axis, he could only account for this fixed position of the earth by imagining it to revolve round the moon at the same rate as the moon rotated. Astronomers in the earth do not admit this: they say the moon passes round the earth. How, then, do they reconcile the moon's axial rotation with the fact of the earth not appearing to describe a circle in the opposite direction to the astronomer in the moon?

I am, Sir, yours obediently,

Cambridge, Jan. 16, 1864. AN ENQUIRER.

THE MOON CONTROVERSY.*

One "Cyclops" hight, from London dates his song,
And eloquent in measured numbers waxes,
To prove that all astronomers are wrong
Quoad the Moon's rotation on her axis.
Perhaps to a countryman, whose own belief
In such rotation still remains unshaken,
You'll spare a little space, that he a brief
Account may give of means which may be taken
To give a popular idea of this rotation;
And, it may be, to furnish refutation

* [Having admitted versification on this subject, we cannot refuse insertion to these lines, but fear they are scarcely so serious as the subject requires.—Ed.]

Of those peculiar views which though o'erthrown
Some years ago in prose, now verse have grown,
And that "One Eye" may not say I alone
Unanswered fallacy in rhyme have shown,
I of a well-known air appear as chanter—
("Similia similibus curantur").

A table first let Cyclops get,
A lamp then in its centre set,
His face towards it turn, and let
Me tell him that I'll prove I'm yet—
    Right too! 'tis true *my* eyes are plural,
    A Cyclops I'm not, of that be sure all;
    But trust that one kindly will endure all
        This truly rural lay.

Well, facing the lamp, then let him bind
A string to himself somewhere behind,
The other end round the fender twined,
And it won't be long ere I am, he'll find,
    Right too! 'tis true, &c. &c.

Now round the table let him pace,
Towards the lamp always keeping his face;
And when he returns to his starting place,
To admit me, I think he'll have the grace,
    Right too! 'tis true, &c. &c.

For about his body it will be found
The string has just once been neatly wound,
Which shows on *his* axis he must have turned round;
And I claim to be, upon that ground,
    Right too! 'tis true, &c. &c.

Now Cyclops is the Moon, and the lamp 's the Earth;
And I of this proof conceive this the worth,
That an axis here moves without causing a dearth
Of rotation around it—a notion whose birth
    's not new. 'Tis true *my* eyes are plural,
    A Cyclops I'm not of that be sure all;
    But trust that one kindly will endure all
        This truly rural lay.

OCULI AMBO.

NOTES AND GLEANINGS.

A New Star Catalogue is being compiled by M. Hoek, of Leyden, and others, to include all stray stars chronicled in the scientific periodicals. The epoch is 1855, and already 2,500 stars have been collected.

Planet No. 79.—This new planet has been named *Eurynome*. The following elements by Tischler are from the *Astronomische Nachrichten* of January 16:—

Epoch 1863. Sept. 14·0. B.M.T.

		°	′	″
M	=	333	20	3
L	=	17	43	35
ϖ	=	44	23	31
☊	=	206	41	0
ι	=	4	36	29
ϕ	=	11	16	36
Log. a	=	0·3880360		
μ	=	928·7783″		

N.B.—In the last number of the Monthly Notices the minor planet, 65, hitherto named Maximiliana, is entitled "Cybele."

A New Comet was discovered by M. Respighi, at Bologna, on Dec. 28. Also independently by M. Bäcker, at Nauen, on Jan. 1, and M. Karlinski, at Cracow, on Jan. 9.

The following elements are by M. F. Peters:—

P.P. = 1863. Dec. 28. 46.

		°	′
ϖ	=	60	48
☊	=	304	54
ι	=	65	8
Log. q.	=	9·88979	

Motion, direct.

These elements bear a resemblance too close to those of the comet of 1810 to admit of doubt as to the identity: this would give a period of 53½ years. Now one of the sets of elements assigned to the comet of 1490, namely those by Hind, also strikingly resemble those of the new comet. Between 1490·6 and 1810·7 is a period of 320·1 years; this divided by 6 gives a quotient 53·3; so the identity must be held almost proved.

Meteorological Prediction.—Writing to the *Times* on the 24th of November, and again on the 24th of December, Dr. Plant, of Birmingham, gives it as his opinion that the winter will be one of intense frost. This prediction has been so far fulfilled that at the beginning of January the cold was more intense than it has been since 1860.

Mr. Lowe gives the following for Highfield House Observatory:—

Jan. 6.	Greatest cold at 4 ft.	12·5;	on the grass,	4·0
7.	Do.	do.	7·7;	do.	1·0

The following is from a correspondent on the same subject:—

(*To the Editor of the Astronomical Register.*)

Sir,—As they may be useful for comparison with the temperature of other localities, I send you the readings of my thermometer (exposed in shade) at Upper Holloway, for the past week of sharp frost:—

	Min.	Max.		Min.	Max.
January 4	19° Fahr.	25°	January 8	20° Fahr.	—
5	19° „	25	9	— „	33
6	12 „	25*	10	33 „	31†
7	15 „	26	11	31 „	48

The maximum of the 8th, and minimum of the 9th, were unobserved owing to absence.

Faithfully yours,

January 11, 1864. G. W.

* On the 6th, the temperature at 10 a.m. was 20°. † at 5 p.m.

ASTRONOMICAL OCCURRENCES FOR FEBRUARY, 1864.

DATE.		Principal Occurrences.		Jupiter's Satellites.		Meridian Passage.
		h. m.			h. m. s.	h. m. Venus. — A. M.
Mon	1	 13 46	Sidereal Time at Mean Noon, 20 43 50·1 Conjunction of Moon and Jupiter, 0° 58′ N.			9 20·9
Tues	2		*The Meridian Passage of Venus, taking place in the Morning, is given in *Civil Time*			* 9 22·1
Wed	3		Declination of Venus, S. 21° 49½′	1st Ec. D.	18 38 57	9 23·3
Thur	4	10 1 11 4	Conjunction of Moon and Venus, 1° 49′ S. Conjunction of Moon and Mars, 3° 51′ S.	1st Sh. I. „ Tr. I. 2nd Ec. D. 1st Sh. E. 1st Tr. E. 2nd Ec. R. „ Oc. D.	15 50 17 3 17 10 21 18 2 19 15 19 25 10 19 34	9 24·5
Fri	5	17 42 18 58	Conjunction of Mars and Venus, 1° 57′ N. Conjunction of Moon and Mercury, 1° 54′ S.	1st Oc. R.	16 30	9 25·8
Sat	6			2nd Sh. E. „ Tr. I. „ Tr. E.	14 13 14 19 16 36	9 27·0
Sun	7	6 10	● New Moon			9 28·2
Mon	8			3rd Tr. I. „ Tr. E.	15 6 17 1	9 29·4
Tues	9					9 30·6
Wed	10					9 31·9
Thur	11		Declination of Venus, S. 21° 41½′.	1st Sh. I. „ Tr. I.	17 43 18 57	9 33·1
Fri	12			1st Ec. D. „ Oc. R.	15 0 42 18 25	Moon. — 4 23·0
Sat	13			1st Sh. E. 2nd Sh. I. 1st Tr. E. 2nd Sh. E. „ Tr. I. „ Tr. E.	14 23 14 28 15 37 16 49 16 57 19 14	5 14·5
Sun	14	1 24	☽ Moon's First Quarter			6 5·8
Mon	15			2nd Oc. R. 3rd Sh. I. „ Sh. E. „ Tr. I.	13 42 13 57 16 5 19 7	6 56·8

DATE.			Principal Occurrences.	Jupiter's Satellites.		Meridian Passage.
		h. m.			h. m. s.	h. m.
Tues	16	3 14 15 40 16 28	Conjunction of Moon and Uranus 2° 31′ N. Occultation of χ^2 Orionis (6) Reappearance of ditto.			Moon — 7 47·0
Wed	17		Sidereal Time at Mean Noon, 21 46 55.			8 35·9
Thur	18	11 26	Greatest Westerly Elongation of Mercury, 26° 31′			9 23·4
Fri	19			1st Ec. D.	16 54 8	10 9·3
Sat	20	6 32 7 34 14 35 15 33	Occultation of 60 Cancri (6) Reappearance of ditto Occultation of κ Cancri (5) Reappearance of ditto	1st Sh. I. " Tr. I. " Sh. E. 2nd Sh. I. 1st Tr. E.	14 4 15 18 16 16 17 3 17 30	10 53·7
Sun	21			1st Oc. R.	14 46	11 36·8
Mon	22	5 1	☉ Full Moon	2nd Ec. R. " Oc. D. " Oc. R. 3rd Sh. I.	13 47 14 13 58 16 14 17 54	Venus. — A.M. 9 46·4
Tues	23					9 47·6
Wed	24					9 48·7
Thur	25	13 22	Near approach of Moon to ψ Virginis (5)			9 49·9
Fri	26	0 21	Conjunction of Moon and Saturn, 5° 46′ N.	3rd Oc. D. " Oc. R. 1st Ec. D.	13 8 14 57 18 47 34	9 51·0
Sat	27			1st Sh. I. " Tr. I. " Sh. E.	15 56 17 10 18 8	9 52·1
Sun	28			1st Ec. D. " Oc. R.	13 15 59 16 38	9 53·2
Mon	29	0 14 18 19 19 33	Conjunction of Moon and Jupiter, 0° 33′ N. Occultation of ω Ophiuchi, (5) Reappearance of ditto	1st Tr. E. 2nd Ec. D. " Ec. R. " Oc. D. " Oc. R.	13 49 14 5 30 16 20 10 16 29 18 45	9 54·3

TABLE OF NEBULÆ.

Right Ascension, Five Hours.

NAME OF NEBULA.	Right Ascension.	Declination.
79 M. Leporis	5 18 50	−24 38½
Tolerably bright: showing evident traces of condensation towards its centre.		
261 Hersch. i. Aurigæ ...	5 22 30	+34 8½
A very small nebula in a pretty field of stars: there is a minute triangle of stars upon the nebula itself.		
1 M. Tauri	5 26 20	+21 55½
A fine large and relatively bright nebula in a field of small stars.		
θ^1 Orionis	5 28 40	− 5 29
The most wonderful nebula in the heavens! surrounding a multiple star.		
34 Hersch. iv. Orionis ...	5 34 45	+ 9 1
A planetary nebula, small, dim and pale, surrounded by small stars.		
78 M. Orionis	5 39 50	+ 0 1½
Two minute stars, surrounded by a tolerably bright nebulous glow.		

The Fifth hour of Right Ascension derives much interest from the fact of its containing that superb object, the great nebula in Orion's sword-hilt, surrounding the multiple star θ^1 Orionis, an object in which every increase of aperture reveals fresh beauties. Viewed in the class of instruments to which our descriptions apply, it will be seen as a flocculent mass of light, condensing about a trapezium formed by four small stars: to the right of this trapezium a densely dark gap, entirely free from any trace either of stars or light, will be seen. This has been called "The Fish's Mouth." Trending from the south of this gap, the nebulosity goes up in a S.E. direction, like the proboscis of some animal, immersing three conspicuous stars which lie across the field of view in a somewhat sinuous line. To the left, or preceding the trapezium, the flocculent nebulosity will be seen to melt into the dark ground of the heavens. While with a low power, near the bottom of the field, an isolated star will be perceived, surrounded with a nebulosity of its own. As, however, no verbal description can possibly do justice to this glorious object, we must refer our readers to θ^1 Orionis itself, and proceed to notice the remaining objects in our list. 79 M. Leporis calls for no remark beyond that it is bright considering its proximity to the horizon. By the employment of a moderately high power upon 261 Hersch. i. Aurigæ, and by earnest and sustained attention, the observer will perceive a minute triangle of stars to glitter up upon this little nebula. Attentive gazing at 1 M. Tauri will show a kind of mottled effect, which would almost pass for a sign of resolvability. 34 Hersch. iv. Orionis will scarcely repay observation; but the concluding member of our table, 78 M. Orionis, is very curious, precisely resembling a double star when looked at through an eye-piece covered with dew.

THE PLANETS FOR FEBRUARY.

Mercury passes from Sagittarius into Capricornus during the month, and will be favourably situated as a morning star about the middle of February. At the beginning of the month it rises about half-past six in the morning.

1st.	R.A.	19 52 57	Decl. S.	17 31½	Diameter	9″·4
29th	„	21 14 11	„	17 25	„	6″·0

Venus rises from a quarter past to half-past five during February, and is in the same constellations as Mercury.

1st.	R.A.	18 4 53	Decl. S.	21 46	Diameter	15″·2
29th.	„	20 28 40	„	18 58½	„	13″·2

Illuminated portion of the disc of Venus—0·765.

Mars may perhaps be detected in the mornings, but is not yet well placed for observation. It is in the constellation of Sagittarius.

1st.	R.A.	18 14 10	Decl. S.	23 52
29th.	„	19 43 26	„	22 9

Jupiter rises about half-past two in the morning at the beginning, and about midnight at the end of the month. It remains in the constellation Libra.

1st.	R.A.	15 32 3	Decl. S.	18 3	Diameter	33″·4
29th.	„	15 41 15	„	18 30½	„	36″·4

Saturn continues in the constellation Virgo, rising about a quarter before eleven in the evenings at the beginning, and about a quarter before nine at the end of the month.

1st.	R.A.	13 10 21	Decl. S.	4 42½	Diameter	16″·6
29th.	„	13 7 21	„	4 15½	„	17″·0

Dimensions of ring—Outer major axis = 42″·0. Outer minor axis 8″·0.

Uranus continues well placed for observation in Taurus, not setting until between four and five in the morning.

2nd.	R.A.	5 22 20	Decl. N.	23 19	Diameter	4″·0
26th.	„	5 21 5	„	23 18		

Neptune may still be seen, setting in the west during the evenings.

2nd.	R.A.	0 16 56	Decl. N.	0 16½
26th.	„	0 19 37	„	0 34½

THE MINOR PLANETS.

The following are the Minor Planets which will be on, or within one hour of Right Ascension on either side of, the Meridian, between nine and twelve o'clock during the evenings of February. Their places are to be found in the supplement to the *Nautical Almanac* for 1867.

	Magnitude.		Magnitude.
Egeria	9·6	Asia	12·6
Themis	10·4	Leto	10·6
Pomona	10·7	Panopea	12·1
Nysa	9·6	Niobe	10·8
Aglaia	11·9	Feronia	—
Melete	12·6	Galatea	—
Concordia	11·5	Eurydice	—

TEMPERATURE OF 1863.—Mr. W. C. Burder, of Clifton, gives the following as the maximum and minimum temperature of each month for 1863, and the comparison with the average of the last 11 years:—

1863.	Max.	Min.	Average.		1863.	Max.	Min.	Average.	
Jan.	54·4	26·2	2·1	above	July	83·1	40·9	0·8	above
Feb.	54·2	26·1	4·2	„	Aug.	78·8	41·5	0·4	„
Mar.	61·8	27·1	2·3	„	Sept.	66·6	37·9	2·9	below
April	65·4	29·7	2·4	„	Oct.	62·9	33·8	0·2	„
May	69·6	30·3	0·0	equal	Nov.	58·6	28·6	4·9	above
June	73·9	46·4	1·1	below	Dec.	53·1	29·2	3·9	„

The following comparison of the last six years is from Mr. Lowe's report:—

	Greatest Heat.	Greatest Cold.	Mean Temperature.	Rainfall.
1858	92·2	13·2	49·0	18·9
1859	89·5	7·0	49·0	22·4
1860	79·8	8·0	46.5	32·5
1861	82·8	16·5	48·4	22·5
1862	77·7	18·5	48·7	23·9
1863	87·2	24·0	49.4	18·0

CONTENTS.

The Astronomical Register.

No. 15. MARCH. 1864.

ON THE STRUCTURE OF THE LUMINOUS ENVELOPE OF THE SUN.

By James Nasmyth, Esq., C.E.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—I send you a copy of my original paper on the subject of the structure of the luminous envelope of the Sun, in which I first announced my discovery of the *willow-leaf*-shaped objects of which I found the entire luminous envelope to be formed. As no other authentic account of this discovery, save the one I send you, and that in Sir John Herschel's beautiful account of the Sun in the April number of "Good Words," has appeared, and there is much curiosity on the subject, I am fain to think that a reprint of the communication in question in your *Register* would prove very acceptable to a majority of your readers.

Yours very faithfully,

JAMES NASMYTH.

Penshurst, Kent, Feb. 13, 1864.

In order to obtain a satisfactory view of these remarkable objects, it is not only requisite to employ a telescope of very considerable power and perfection of defining capability, but also to make the observation at a time when the atmosphere is nearly quite tranquil, and free from those vibrations which so frequently interpose most provoking interruptions to the efforts of the observer; without such conditions as I allude to, it is hopeless to catch even a glimpse of these remarkable and delicate details of the solar surface.

The filaments in question are seen and appear well defined at the edges of the luminous surface where it overhangs "the penumbra,"

as also in the details of the penumbra itself, and most especially are they seen clearly defined in the details of "the bridges," as I term those bright streaks which are so frequently seen stretching across from side to side over the dark part of the spot.

So far as I have yet had an opportunity of estimating their actual magnitude, their average length appears to be about 1,000 miles, the width about 100.

There appears no definite or symmetrical arrangement in the manner in which they are scattered over the surface of the Sun; they appear to lie across each other in all possible variety of directions. The thickness of the layer does not appear to be very deep, as I can see down through the interstices which are left here and there between them, and through which the dark or penumbral stratum is rendered visible. It is the occurrence of the infinite number of these interstices, and the consequent visibility of a corresponding portion of the dark or penumbral stratum, that gives to the general solar surface that peculiar and well-known mottled appearance which has for a long time been familiar to the observers of the Sun.

I consider the penumbra to be a true secondary stratum of the Sun's luminous envelope, and that what is termed the penumbra of a spot is simply a portion of it, revealed to us by the removal so far of the external and most luminous envelope.

A slight approach to symmetrical arrangement of the details may be observed at the edges of the exterior luminous envelope as it appears surrounding the edge of the spot, and the same may be seen at the edges of the penumbra; the tendency to symmetrical arrangement being a slight approach to a radial formation; the filaments tending in their general position, at the parts in question, to the average centre of the spot.

I may also here note that, although I have carefully watched for it, I have never seen any indication of a vortical or spiral arrangement of the filaments within or about any of the solar spots: this observation appears to set aside all likelihood of any whirlwind-like action being an agent in the formation of the spots, as has been conjectured was the case.

When a solar spot is mending up, these luminous filaments, or willow-leaf-shaped objects (as I term them), are seen to pass from the edges and extend across the spots; if these are carefully observed under favourable conditions, the actual form of these remarkable details, of which "the bridges" are composed, will be revealed to sight.

The details of the penumbral portion of the spot are slightly varied in brightness; that portion of the penumbra immediately under the bright edges of the external luminous envelope is less bright than the

part of the penumbra next the dark centre of the spot. This is not a mere effect of contrast, but an actual variation in brightness.

Portions of the details of the penumbra are in patches considerably brighter than the rest. This effect appears to me to be due to such portions of the penumbra, or the filaments forming it, being more elevated, and consequently brought up into more close contact with the luciferous atmosphere which I am of opinion surrounds the Sun, and excites, by some peculiar action, the willow-leaf-shaped filaments into full luminosity. This of course is only conjecture at present, but I have some pretty strong grounds for entertaining this view of the subject.

The third luminous envelope may be observed like a *mist* underneath some portion of the penumbra. This mysterious object is very difficult to catch a glimpse of, as its comparative brightness is of so very low an order that it is but faintly distinguishable from the darkest portion of the centre of the spot.

I do not as yet feel warranted to hazard any conjecture as to the nature and special functions of these remarkable willow-leaf-shaped details of the solar surface which I have discovered. In the meantime I hope the hasty description I have endeavoured to give may prove in some degree interesting, and excite some of our "observers" to devote a little more of their attention to the glorious centre of our system than, I am sorry to say, has been the case hitherto.

[The only portions omitted of the original communication of Mr. Nasmyth, are the parts relating to the drawings, which we are unable to give.—Ed.]

ROYAL ASTRONOMICAL SOCIETY.

Fourth Meeting, 12th February 1864.—The Annual General Meeting of the Society.

The Rev. R. Main, *Vice-President*, in the Chair.

Secretaries, Rev. C. Pritchard and Mr. Hodgson.

Capt. J. Higgens,	R. Webster, Esq.,
H. Rowe, Esq.,	J. Hennessey, Esq., and
A. Cooper, Esq.,	G. F. Chambers, Esq.,

were balloted for, and duly elected Fellows of the Society.

The Report of the Council to the Forty-fourth Annual General Meeting and the Treasurer's accounts were read, showing that the Society was £200 better than at the last General Meeting.

The principal work done at the various observatories was described: at Greenwich, the agreement for dividing the labour of observing the

small planets between that observatory and Paris had been successfully carried out; and some excellent observations on the nebula of Orion had been made by Mr. Carpenter, who considered that the drawing of Sir John Herschel gave a more faithful representation of the nebula than the later one by Mr. Bond; the other work of the observatory had gone on as usual. At Edinburgh, in addition to the meridian observations of stars, Professor Smyth had been fully occupied with the transmission of *time signals* to various towns, and the publication of the volume of *Proceedings*. At the Radcliffe Observatory, Oxford, no change had been made: Mr. Main was well satisfied with the Carrington transit circle: the second volume of the *Radcliffe Star Catalogue* was in preparation. At Cambridge, Mr. Graham, late of Markree, had been appointed first assistant; the Equatorial had been put in order by Mr. Simms, and the Graham clock by Mr. Frodsham. At Liverpool, the duties connected with the rating of chronometers had much increased, owing to the maritime community availing themselves more fully of the increased facilities afforded. At Glasgow, Professor Grant had been engaged in transmitting *time* to the City and to Port Glasgow; the Equatorial had also been furnished with a micrometer for observing the minor planets, &c. At Cranford, Mr. De la Rue had been enlarging lunar negatives; also replacing the specula of his telescope by others of silvered glass, which he found reflected a much greater amount of light than those of metal; and at Ely, the time of Professor Selwyn and his assistants had been devoted to solar autographs.

The science of Astronomy had continued to progress during the past year, in the annals of which the first place must be given to the correction of the solar parallax, hitherto accepted at 8″·56, from the observation of the transit of Venus in 1769, but now altered to 8″·95, from M. Le Verrier's investigations into the movements of Mars, Venus, and the Moon; from Hansen's discussion of the parallactic inequality in the lunar theory; from M. Leon Foucault's mechanical determination of the velocity of light; and lastly, from the observations of Mars at the last opposition. Le Verrier's value is 8″·95; Hansen's, 8″·9159; Mr. Stone's, from a comparison of the observations of Mars made at Greenwich and in Australia, 8″·932. Simultaneously with this correction of the sun's distance, a diminution of 26 miles in the moon's distance has been discovered to be necessary—from observations made in Europe and at the Cape of Good Hope, between 1834 and 1837, and recently compared by Mr. Breen.

A subject of special interest has been the renewed attempt to determine the movement of the solar system in space—and, although the Astronomer Royal agrees very nearly with Sir William Herschel as to the point to which it is directed, he still confesses that the

matter remains for the present in doubt and abeyance. The discovery of the small companions of Sirius by M. Goldschmidt, confirming Bessel's hypothesis of hitherto invisible bodies connected with Sirius and Procyon, may possibly have some bearing on this subject.

The discovery of the parallax of two or three fresh stars by M. Kruger; the projected formation of a Catalogue of Stars in the Southern hemisphere; the Astronomer Royal's investigation into the cause of the discordance between observations by direct view and by reflection from quicksilver; the influence of surrounding geological conditions on the plumb-line, causing an error of 8″ in the direction for gravity, discovered by Professor Schwerzer of Moscow—these have also been subjects of great interest during the past year, which has moreover been distinguished by the publication of Mr. Carrington's volume on the Solar Spots, a model for future efforts, and an admirable volume on Astronomy by Mr. Main.

A discussion on the constitution of the Sun and the nature of its envelopes has also taken place, principally referring to the willow-leaves of Mr. Nasmyth, to which two papers of a very interesting character were contributed by the Rev. W. R. Dawes.

The President's Address.

Mr. Main said, that after all they had heard of the satisfactory progress of the science of Astronomy, he had a statement to make that would take them a little by surprise, and possibly cause some disappointment. There was no "President's address!" And it was owing to this—that the council of the Society, after much consideration of the subject, had come to the determination that the interests of Astronomy would be best consulted by giving no medal this year. It was not that they could find no worthy candidates—not that no work had been put forward deserving of the medal—but that they thought they ought to wait until some of the great problems now in progress were more fully worked out. No science had shown such marks of progress during the past year as the science of Astronomy, either in theory or practice; improved methods—improvements of instruments—had kept pace with each other. He would allude particularly to photography, and could not do so without referring to the successful labours of Mr. De la Rue in that interesting branch of the science. On the whole, there was every hope that Astronomy would continue to be the inexhaustible subject it had hitherto been found, and that its cultivators would never weary. Mr. Carrington's great work was an instance of what could be done by the most unwearied perseverance and careful attention to details. Mr. Main concluded with a hope that enough had been said to prevent any

feeling of disappointment at the want of the usual "President's speech."

An alteration in the Bye-Laws of the Society was proposed and carried, in order to procure better payment of the arrears of subscriptions.

The following Officers were then elected for the ensuing year:—

President, Warren De la Rue, Esq., F.R.S.

Vice-Presidents.	*Treasurer.*
Professor Adams, M.A., F.R.S.	S. C. Whitbread, Esq., F.R.S.
G. B. Airy, Esq., M.A., F.R.S.	*Secretaries.*
John Lee, Esq., LL.D., F.R.S.	Richard Hodgson, Esq.
C. B. Vignolles, Esq., F.R.S.	Rev. C. Pritchard, M.A., F.R.S.

Foreign Secretary, Admiral R. H. Manners.

Council.

Professor Cayley, M.A., F.R.S.	Rev. R. Main, M.A., F.R.S.
R. C. Carrington, Esq., F.R.S.	Rev. Professor Selwyn, B.D.
Edwin Clark, Esq.	Major-General Shortrede.
James Glaisher, Esq., F.R.S.	James Simms, Esq.
William Huggins, Esq.	E. J. Stone, Esq., M.A.
J. R. Hind, Esq., F.R.S.	Lieut.-Colonel A. Strange.

CORRESPONDENCE.

N.B.—We do not hold ourselves answerable for any opinions expressed by our correspondents.

ALPHA ARIETIS.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—I should be much obliged if one of your correspondents would furnish me with the position and distance of the small companion of α Arietis, a star which has puzzled me a good deal lately. My attention was first drawn to it by seeing it in a list of test-objects for "illuminating power" given in Loomis's *Practical Astronomy*, p. 246, where the star is described as being of the 3rd and 11th magnitudes, with a distance of 30″. Now, at pages 25 and 26 of the same work, it appears, by an extract from the *Celestial Cycle*, that this star was one among several others experimented on by Admiral Smyth with the aperture of his telescope reduced by diaphragms; and after mentioning several stars, including α Lyra, which he readily saw with the four-inch aperture, he proceeds thus:—"But it required the full aperture and powers of from 24 to 300, with favourable circumstances, to scrutinise satisfactorily the following test-objects: α Arietis," &c. &c. On

referring to the second volume of the *Cycle*, I was much surprised to find that no notice whatever is taken of this minute companion.

The following is an extract from the description, p. 52:—"Position, 107°·3; difference of R. A., 19s·5; epoch, 1835·10. A 3, yellow; B 11, purple. The large star is followed by three small ones, forming a line across the parallel, of which the middle individual is B." It is evident from the large difference of right ascension here given, that B could not be the companion which required the full aperture to scrutinise; in fact, the Admiral appears unaccountably to have entirely overlooked this minute comes, when he made the observation recorded in the second volume of the *Cycle*.

Being much puzzled, and being quite certain that my equatorial of only four inches' aperture would have no chance with such an object, I asked my friend Mr. Bird to examine it with his excellent silvered-glass reflector of twelve inches' aperture. To my great surprise, after a most careful scrutiny, he failed in detecting any star of the 11th magnitude at all answering to Loomis's description; indeed, he does not appear to have seen any comes which would constitute the star the difficult test which the Admiral's account of his experiments, as recorded in the first volume and quoted above, would lead one to consider it. With a power of 200 on my telescope, I readily saw the three companions mentioned by the Admiral, as above quoted (when are we to be favoured with the second edition of his most interesting work?) and several times had the impression that I *glimpsed* a most minute star involved in the radiations of the larger one, with a roughly estimated position of about 300°; but Mr. Bird did not appear to confirm this. *a* Arietis is not in Herschel and South's catalogue, and, unfortunately, I am not able to refer to Struve's great catalogue.

I remain, Sir,
Yours obediently,
GEORGE HUNT.

Edgbaston, Birmingham,
January 15, 1864.

P. S.—In the notice about the moon, which you kindly inserted in the 13th number, the date ought obviously to be 1863, not 1862.

COMPANION OF PROCYON.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—I beg, through the medium of the *Register*, to call attention to a severe but convenient test-object. I refer to the small star in the same field and immediately following Procyon, and nearly on the same parallel. For some months past I have suspected the star to be double; and on Tuesday last, February 9, succeeded in separating very distinctly the components with my silvered-glass speculum of twelve inches' aperture. They seem to be 9·5 and 9·8 magnitude stars respectively, and Mr. Knott, who has since seen them with his refractor, tells me he thinks their angle of position is about 200°.

At some distance north preceding, is a 14th magnitude comes, which, with the close pair, form a most delicate triple combination.

Can the close pair above referred to be the star mentioned by the Rev. T. W. Webb in his *Celestial Objects for Common Telescopes*, in connection with Procyon? He calls it a curious variable star, about 2½′ distant, very nearly f.—8 mag. Smyth, 1833; 9 mag. Fletcher, 1850; missed by Bond 1848, Fletcher 1853, Hind 1853–4–5.

I am, Sir, yours faithfully,
FREDERICK BIRD.

General Cemetery, Birmingham,
Feb. 15, 1864.

DOUBLE STAR IN TAURUS.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—A few nights ago, whilst observing the stars in the neighbourhood of β Tauri, I found a very close double, which is not noticed in Smyth, nor can I find any record of it elsewhere. The observation was made with my 8-in. equatorial, and with a power of 350, the object is a very fine minature of η Coronæ, both stars being of the 8th magnitude and golden yellow. Mr. Buckingham has measured the object with his 5-in. equatorial, and has kindly sent me the following:

A. R. 5h. 28m. 51s.
Dec. N. 26° 50′ 13″
Position 189°. Distance 0″·9.

Can any of your readers inform me whether this star has been previously registered? If not already well known, I think it would be a very interesting object to watch for indications of physical connection.

I am, Sir, yours truly,
WM. WRAY.

1 Clifton Villas,
Highgate Hill, N.

KAPPA CANCRI.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—May I submit the following suggestion (if not already made), as a possible explanation of the gradual disappearance of Kappa Cancri, which has been again noticed in your columns. During an occultation of Jupiter some years since, a part of his disc was seen partially obscured, as if by a collection of vapour in a lunar hollow. If Kappa Cancri were occulted by such a "fog-sea," it appears to me that its gradual disappearance would be accounted for, and also the variation in its duration, according to the aperture used, the larger aperture allowing the star to be seen through a thicker stratum of fog. Of course, to an observer so situated as to see the occultation at a solid part of the moon's disc, it would appear instantaneous as usual.

I am, Sir, your obedient servant,
W. H. WHEELER.

Oxford, Jan. 7, 1864.

THE PLANET VULCAN.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—Circumstances prevented me noticing last month the criticism of your correspondent "Juno" on the intra-mercurial planet. May I now offer a few remarks in self-defence?

"Juno," though I can scarcely understand it, does not seem to be acquainted with any of the literature dealing with the question, except Mr. Hind's letter to the *Times*. If *she* will consult a file of the *Monthly Notices*, she will find in various places communications bearing on the new planet, in such a way as to place (it seems to me) the probability of its reality in a very striking light. In addition to the references cited in my *Handbook of*

Astronomy, which, to save your valuable space, I shall not requote, the following is a very important one. *Month. Not.* vol. xxii. p. 232.

In a few words, the case for the plaintiff is this:

1. From Lescarbault's observations approximate elements can be assigned.
2. From Lummis's observations, no less a calculator than M. Valz has deduced elements strikingly of accord with those obtained for Lescarbault's planet.
3. Other instances are on record of black spots traversing the sun's disc which presented appearances such as an inferior planet does present when *in transitu*.

The only evidence (!) on the other side is "*I don't believe it.*" I submit that the probability of there being an intra-mercurial planet is considerable, to say the least of it. The positive testimony of respectable witnesses that they did see *something*, in a court of law, always, as a rule, outweighs negative testimony, from however distinguished a quarter it comes. I understand Le Verrier in a sense different from what "Juno" does. The assertion that a body of small planets would account for certain disturbances by no means implies that *one* (Lescarbault's), or two or three good-sized ones, would not.

I am, Sir, your obedient servant,

Feb. 13, 1864. G. F. CHAMBERS.

DARKNESS AND LIGHT.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—On casting my eye over the pages of your February number this morning, my attention was arrested by the signature "Readingensis," which seemed to me the shadow of a friend. Two questions present themselves to his mind as difficulties, and it appears to me that the same reply may be given to both. The first is, "How can there be any darkness?" and the second, on which he appears to lay more stress, is, Why we cannot trace the beams of light passing from the sun to those opaque bodies of our system which he illuminates?

I hope all astronomers are too courteous to stigmatise the difficulties or queries of their brethren as "*nonsensical*" (a term not unfrequently applied to views which are sensible enough, but only not understood, or misunderstood, by those who deride them). Your correspondent appears to think that a result of the universal diffusion of light from the solar photosphere would be, that darkness could not exist even in such cases, for example, as that of our satellite on the side averted from the sun. It would be more to the purpose to enquire why the light called by M. Arago the lumière cendrée—the ashy light by which the entire body of the moon can be seen beyond the fully-enlightened portion for a few days in the waxing phases—is not discernible both earlier and later in the lunation? or, what is the distinction, if any, between the lumière cendrée and that which, during eclipses of the moon, lights up her darkened disk? But it seems that the chief thing which "Readingensis" has overlooked is the fact that the enlightening rays of the sun require, in order to become appreciable to our sight, some solid body to reflect them. *We cannot see light at all. We see only enlightened objects.* We cannot trace the path of a sunbeam—and what your correspondent says of our perceiving his beams penetrating our atmosphere reminds one of the way in which we *may* see sunbeams sometimes in a dusty room, partially admitting light at a half-closed shutter! We then see, in the direction of the admitted rays, lines of dust and particles infinitely

minute, but of solid matter, diffused through the apartment through the negligence of the housemaid. The beams which we sometimes observe slanting down through our atmosphere (for which the housemaid is not to blame) are referrible, in part at least, to an analogous cause. We see enlightened vapours and also lines of enlightened space contrasting with the surrounding clouds and vapour. If from any spot on the earth's surface, turned away at the time from the sun, we should look forth into space, and if in our line of sight there should chance to be a solid body capable of reflecting light beyond the apex of a cone of our shadow, and of sufficient magnitude, we should see it plainly enough as we do see a planet projected on a dark ground of sky. Your correspondent's closing sentence, in which he suggests a hopeless solution of his difficulties, I must confess my entire inability to understand.

I remain, Sir,
Yours faithfully,
MORTIMERENSIS.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—In reply to your correspondent "Readingensis," the solution of his difficulty is, I think, an easy one, and his question—"*How can there be any darkness?*"—is not by any means so nonsensical as it might at first appear. I do not affirm that there can be no *absolute darkness*, but used as a general term, darkness can be only an expression of degree. The hypothesis of the progression of light molecules is too subtile a subject now to enter upon; but I think one thing is evident regarding them, that, in order to render them visible, some material body must be opposed to their path by which they may be reflected to the eye.

The sunbeam that enters a room through some small opening in the blind, is frequently very distinctly seen throughout its path simply on account of the numberless particles of dust held and suspended in the air; so the beam darting through a cloud is sometimes (not always) clearly traced from cloud to earth, or upwards, on account of its reflection upon the watery or other particles in suspension in the atmosphere. If your correspondent will take a lantern in which there is a lens, such as a common dark lantern, for instance, and then make a smoke in front of the lens in a dark room, he will be able to trace clearly and sharply the path of the divergent rays, which otherwise would be nearly or quite invisible. The path of the sun's rays, viewed from the earth, into space are not therefore visible on account of the transparent ether through which they pass; this gives us our dark sky, and which in the steppes of Asia, where the atmosphere is wonderfully pure, approaches even to a *black* sky.

I am, Sir, yours obediently,
Uckfield, Sussex. F. B.

WEATHER PREDICTIONS.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—Finding in the *Astronomical Register* some remarks respecting the weather predictions of Mr. Thomas Plant, of Birmingham, perhaps you will kindly allow me a few words in reply. Mr. Plant has promulgated three theories respecting the weather recently, viz.: 1st. That when the mean temperature of part of the year is much above or below the average, it is

usually compensated by a period below or above the average during some other part of the same year. 2nd. That when November has a mean temperature above the average it is usually followed by severe cold between December and March following. 3rd. That a mild autumn is always followed by a cold winter. As regards the two first statements, I enclose abstracts of two papers I have recently read before the Literary and Philosophical Society of Manchester, very clearly proving both statements to be entirely devoid of truth, as they will not stand the test of the observations of mean temperature for the last 92 years.

As regards the third statement, our most severe winters were generally preceeded by *cold* autumns, in place of warm ones; for example, 1813 to 1814, 1837 to 1838, and, in addition, the warm autumns of 1827, 1833, and 1848, were followed by warm winters. As I have carefully examined the mean temperature of every month from 1771 to 1862, I am in a position to state that this long period of 92 years shows most distinctly that there is no truth whatever in the third of his propositions.

As you have inserted a memorandum of his prophecy, I trust you will also insert this reply.

I am, Sir, yours truly,
G. V. VERNON, F.R.A.S.

Old Trafford, Manchester, Feb. 2, 1864.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—In the current number of your valuable *Register* I perceive an article headed "Meteorological Predictions," in which the writer refers to the so-called prediction of Mr. Plant (not Dr. Plant), of Birmingham, to the effect that the present winter would be one of great severity. Will you kindly permit me to inform the writer of the article above referred to that *real* meteorologists do not predict the weather at all, for the simple reason that *no data are at present known to exist upon which any such predictions can be based?* Those of your readers who take an interest in this subject I would recommend to peruse the article by Sir John Herschel, on "Weather and Weather Prophets," in the January number of *Good Words.*

I remain, Sir, your obedient Servant,
JOHN THRUSTANS, M.B.M.S.

Wolverhampton, February 19, 1864.

THE SUN'S MOTION IN SPACE.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—With reference to Mr. Reddie's letter in the last number of your valuable journal, there can be no doubt that the various points he touches upon are of the greatest importance; and I cannot find that they have been noticed by astronomers or mathematicians since Sir William Herschel's suggestion of the motion of the solar system towards λ *Herculis* was first made.

But your correspondent is not quite right in saying that *whatever* be the direction in which the sun moves, the motion of the bodies which revolve round it must always differ twice a-year by the *whole* amount of the sun's motion in space. It is approximately true, no doubt, as regards the various motions which have been ascribed to the sun; but would be precisely true

only, if all the motions—orbital and translatory—were in precisely the same plane. It would not be the case if the sun moved directly towards the pole-star, or at right angles to the orbits of the planets. I am aware that the sun's motion in space is generally regarded as towards some point in the constellation *Hercules* (or, as Mr. Reddie puts it in his *Victoria Toto Cælo, or Modern Astronomy Recast*, "from the feet of *Orion* to the arms of *Hercules*"), and that the direction of the sun's motion is therefore nearly in that of the plane of the ecliptic. It is also evident, I admit, that there would be great difficulties of another kind to get over, if the sun's path crossed that plane at right angles. In that case, the sun would probably leave the planets behind altogether, or draw them along after it in ever rapidly decreasing orbits of rotation.

As regards the base-line, from the extreme ends of which the fixed stars at right angles to the sun's path are viewed between two intervals of a few years, it is clear, that if the sun moves in space, the diameter of the earth's orbit sinks into comparative insignificance, and may be left out of account altogether: for even in 20 years only, if the sun travels 18,000 miles an hour, the base-line from which these stars are viewed becomes upwards of 3,000 *millions* of miles!

I may add that Mr. Evan Hopkins, in his work on *Geology and Terrestrial Magnetism*, endeavours to account for the precession of the equinoxes from an alleged gradual movement northwards, in a spiral direction, of the whole crust of the earth. This would probably result also in "upheavals and depressions" of the land, and would no doubt disturb the apparent positions of the fixed stars when viewed at considerable intervals of time from the same observatories, as Mr. Reddie suggests.

I have the honour to be, Sir, yours obediently,

February 19, 1864. NAUTICUS.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—In the February number of the *Register* there is a letter from Mr. Reddie on the subject of the "Motion of the Solar System in Space;" in which he asserts that there can be no such motion, because of some fanciful contradictions "to well-known mechanical principles."

I presume it will be admitted that Jupiter with his satellites is strictly analogous to the Solar System, on a small scale, and we can therefore bring Mr. Reddie's assertion to the test of observation.

Substituting *Jupiter* for the *Sun* in the following paragraph of the letter referred to, we shall read, "If Jupiter moves in space, the variations in the orbital velocities of all the bodies that revolve about it *must* differ by the whole amount of Jupiter's motion, when at right angles to its path, twice in every revolution they make." For instance, taking Jupiter's motion at 29,000 miles an hour, the second satellite's mean orbital velocity of 32,000 miles an hour must sometimes be 32,000 + 29,000 = 61,000, and half a revolution afterwards 32,000 − 29,000 = 3,000 miles an hour only.

Now when Jupiter is in opposition, these two points of maximum and minimum velocities will occur at the occultation and transit of the satellites. For instance, taking the second satellite, its velocity at its occultation should be, according to Mr. Reddie, 61,000 miles an hour, it being then moving at a right angle with the planet's path, and in the *same direction*; while at its transit it should have a velocity of 3,000 miles an hour only, as it will be moving at a right angle to its primary's path, but in an *opposite direction*. Therefore the time occupied by the transit of the satellite should be somewhere about twenty times that occupied by the occultation.

But according to observations at previous oppositions, and to the compu-

tation of the times which will be given in the pages of your *Register* for May next, both phenomena occupy a little over two hours, and differ only a few minutes; and the accuracy of your computed times may be confirmed by future observation about 11th May, at which time Jupiter will be again in opposition.

It appears, then, that Mr. Reddie must either deny Jupiter's orbital motion, for precisely the same reasons as led him to conclude the Sun to be motionless, or that he has misapplied the "well-known mechanical principles and necessities of the laws of space and motion."

Perhaps Mr. Reddie will be good enough to state in some future number of the *Register* what I do not quite comprehend in his letter of January 7th. Does he imagine that the "upheavals and depressions of the land" operate by disturbing the adjustment of the instruments used in determining parallax, or that the upheavals and depressions are themselves of sufficient magnitude as to cause variations in the parallax of the fixed stars?

I am, Sir,
Your obedient Servant,
D.

THE MOON CONTROVERSY.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—One of the most extraordinary and amusing things about the moon controversy is, that the illustration which is relied upon by the opponents of the moon's *axial* rotation as best calculated to carry conviction to the minds of those who advocate it, is in fact one of the most convincing which can be adduced on the other side of the question. It was brought forward some years ago; and if it be really true that it and some others have never yet met with a reply, I can only attribute it to the fact, that their suicidal character was thought to render any serious refutation quite superfluous.

Let us look for a moment at the favourite line of soldiers about to "wheel" round the "pivot man;" and as the case is essentially the same with each man except the "pivot," we will, for the sake of simplicity, take the last man in the line—the farthest from the pivot. Now, let it be granted (and it cannot be denied) that if a man keeps his face directed towards the same point of the horizon, say the *north*, he does *not* rotate, or turn on his axis, whatever else he may do. Let this last man in the line keep his face towards the *north*, and start from the *east* side of the circle which he describes about the pivot, towards which his left shoulder is of course directed. When he has arrived at the north side of the circle, his face being still towards the north, his back will be turned to the pivot, and he will have to proceed crab-fashion, and left-shoulder first. When arrived at the next point of the circle, his right shoulder will be towards the pivot, and he will find himself constrained to walk backwards. So at the south point he will face the pivot as well as the north, and will be walking crab-wise again, with the right shoulder first; and so on round to the east point, from which he set out, where he will be walking forwards with his left shoulder towards the pivot. Thus he will have performed one revolution *without* turning on his axis; *and consequently will have presented every side towards the centre.* But if, on the contrary, he is throughout to present the *same side* to the centre (say the left shoulder with which he started), he will find it necessary to turn his face to every point of the compass during his passage round the centre; that is, he *must rotate once on his own axis in the same time as is occupied by his walk round the circle.*

Rotation signifies *turning like a wheel.* Every particle of a rotatory body is carried round the centre *in the same time.* If the moon were carried round the earth in 24 hours, we might reasonably conclude that she was attached to the earth by some rigid though invisible connection, and that her motion was really one of rotation and not of revolution. But as she occupies nearly a month instead of a day in her circuit, and there is nearly the same ratio between her periodic time and her mean distance from the earth as obtains in the other revolving bodies of the Solar System, we unhesitatingly conclude that her motion round the earth is one of *revolution*; and that as she always turns nearly the same face towards us, she must necessarily *rotate* on her axis in the same time as she revolves round her primary.

Sincerely apologising for offering you such elementary explanations, which, however, seem to be rendered necessary by strange misapprehensions on the simplest subjects,

I remain,
Yours faithfully,
W. R. DAWES.

Hopefield Observatory,
Haddenham, Bucks, Feb. 19, 1864.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—Unable to cope with "Cyclops" or "Oculi Ambo" in furnishing rhymes upon this subject, I venture to interpose a few reasons for taking a view somewhat different from that taken either by the gentleman "who had no eyes, and yet went out to view the skies," or by the gentleman who "sees double," and who therefore discovers that the moon both *revolves and rotates* simultaneously every month.

If "Cyclops" will keep in mind that the earth goes round the sun once a year, and the moon only *apparently* round the earth once a month—i. e. supposing him to be a Copernican philosopher, though such "an ancient!" —then he will see, even with one eye, that the moon's *real* path is not a circle or ellipse round the earth, but only a wave-line or undulating path crossing and recrossing the earth's orbit round the sun. All his arguments are based upon the notion that the moon really *revolves once round the earth in a circle* between one new moon and another. But the moon's path in each lunation is a simple wave-line, very slightly differing from the curve of the thirteenth part of the earth's orbit. And though the moon has not in that time described anything like a circle or ellipse, but a simple open arch—less curved, probably, than "Cyclops'" eyebrow when he now elevates it with astonishment—she has, nevertheless, turned fairly once round upon her axis, and so (*not*, as the Cambridge "Enquirer" supposes in your last number, because the earth is in a "fixed position") she has looked all round the earth.

In fact, the moon's real path is nearly a circle round the sun—*not* "a circle round the earth" at all. In describing this circular path once a year, she crosses and recrosses the earth's path every month, sometimes moving faster, sometimes slower than the earth, and thus getting between the earth and sun, sometimes falling behind the earth in her first quarter, then overtaking it and getting before it, in "opposition," and in her last quarter; and *she rotates thirteen times upon her axis during each complete revolution she makes*, and not *once* only, as "Oculi Ambo" and "Argus" blindly maintain. These illuminati, so potent in repetition of all we have heard since we were babies—both found their arguments and illustrations unwittingly upon the hypothesis that the earth (or centre round which they

suppose the moon to move) is *at rest*; and they argue as if "Cyclops" denied both the rotation and the revolving of the moon, whereas he appears merely to maintain that revolution implies rotation, and that, as a top spins round, its centre is "rotating," while any point in its circumference "revolves," or simply "turns round," at a distance from the centre.

As our theoretical astronomy is becoming more and more complicated, I must add that my description of the actual paths of the earth and moon is founded on the heliocentric hypothesis of Copernicus and Newton, *with the sun at rest*, and would be no longer accurate if the sun were really "moving in space."

I am, Sir, your faithful Servant,

Feb. 8, 1864. J. R.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—Thinking the description of an experiment, contrived a few nights since to explain to some friends the object of the lunar controversy, may interest your readers, I venture to append it. Into a wooden stand was fixed an upright piece of stout wire, having on its summit a brass ball to represent the earth; a second piece of similar wire was next wound at one end round the first, so as to turn freely upon it, and at the other end bent at right angles to form a second upright; a ball partially pierced to turn freely on it, surmounts the latter. This ball has a screw by which it can be clamped on to its axis, and also a grooved wheel of wood about two inches diameter fixed to it. A similar wheel was fixed immovably on to the centre pin. If now the movable ball be fixed by the screw, and a mark placed on the side next the central globe, when caused by the arm to revolve in its orbit, it will be found always to have this side next the centre, which is precisely the appearance presented by the moon. If now the outer be freed, and the wheels connected by an elastic belt, it will rotate once during each orbital revolution, which, according to astronomers, the moon does; but it will be seen that the face presented towards the centre of its orbit will constantly change as it revolves, which is not the case with the moon.

If the observer note the effects of the above from a point without the orbit, they will, of course, be reversed, but such a position would obviously in nowise represent that of a terrestrial observer with regard to the moon. Were "Oculi Ambo" to fasten the string to the centre of the table as he should, Cyclops would not wind on himself by revolution about the table without rotation.

If, as "A. L. S." avers, the compass card does not rotate on its axis in his experiment, it cannot be affected by fixture on the latter; let him try the experiment so, and I think the result will hardly help the supporters of the theory of the moon's axial rotation.

I am, Sir, yours obediently,

Streatham Hill, Feb. 16, 1864. S. B. K.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—The question seems to be one of *terms* rather than of *facts*, and may be disposed of, perhaps, by an accurate definition of *rotation*. The derivation of this word is obvious, and gives some clue to its signification. But still there seems a difficulty in giving such a definition of the term as will meet all cases.

If we fix an apple tight to the rim of a cart wheel by a nail driven through

it parallel to the axle, and so that the rosy side may be towards the centre of the wheel, and fix another so as to turn easily round its nail, the rosy side of the latter being loaded; then as the cart proceeds, the tight-fixed apple will always present its rosy side to the centre of the wheel, but this side *will be turned to earth and sky, and opposite horizons, and all points between.* The other apple will always present its rosy side to the ground, and *will rotate on the surface of the wheel.*

Can both apples be said to *rotate?* and is not rotation a term of *relative motion?*

I am, Sir, yours, &c.,

19th Feb. 1864. ANOTHER ENQUIRER.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—"Oçuli Ambo" ought to make better use of his "plural eyes." If he looked deeper into the matter, he would see that a person walking round the table with a string fastened to himself and to the fender, winds the string round himself by *turning round* the lamp in the centre of the table, not by turning round his own axis, as "O. A." assumes. Let him attach the string to himself and to the lamp; then in walking round the table, with his face to the lamp, he will wind the string round the lamp, but not round himself. Next let him walk round the table, with his face to one side of the room, he will then wind the string round himself as well as round the lamp; showing that the motion is not single, but double. He will probably stare with both his eyes when he opens them to the fact that the motion he fancied double is a single movement: and the parallel motion, which he assumed to be single, is really compounded of two movements in contrary directions, which produce parallelism by mutually counteracting each other! If winding the string round himself is a criterion of *rotating* in the one case, as he assumes (erroneously); *he* cannot deny consistently that it is so in the case of parallel motion (which it really is).

"A. L. S." misinterprets his own illustration:

"As any one may ascertain,
Who tests it *thoroughly* again."

If, "by virtue of the directive power of the magnetic needle, the card does not rotate," what is the intent and purpose of delicately poising it on its pivot?

If walking across a circle has the same effect as walking half round it, what does "Argus" suppose becomes of the effect of circular motion—that of turning round? If I walk across a circle, following my nose along the diameter, I keep my face in the same direction all the time. But if I follow my nose along the semi-circumference, I change my direction gradually all the time, and look in the reverse direction when I arrive at the opposite side of the circle. If my nose is always foremost in the line of march, I do not turn on my axis, as I must do if I turn my nose always towards one point of the horizon.

Yours, &c.,

19th February, 1864. CYCLOPS.

THE JURORS' REPORT ON THE HOROLOGICAL INSTRUMENTS in the International Exhibition of 1862 contains a quantity of information of great interest to observers. There are some details with regard to the escapements and pendulums of astronomical clocks which will repay perusal, and many curious points with reference to the acceleration and retardation of rate in chronometers, are touched upon. The Report has been drawn up by Charles Frodsham, Esq., F.R.A.S.

NOTES AND GLEANINGS.

The Lalande Prize of the French Academy has been bestowed on M. Chacomac for his numerous minor-planet discoveries, and his contributions towards celestial chartography.

Two New Variable Stars have been discovered by the indefatigable Argelander. The one, to be entitled U. Piscium, is situated (1855), in R. A. 1h. 46m. 43s.: Decl. + 8° 4'·0. The other in R. A. 23h. 14m. 4s. and Decl. + 55° 19'·5. The former seems to vary between magnitudes 6 and 9; the latter between 8·2 and 8·8.

Obituary.—M. Capocci, of Naples, died at that city on January 10, at the age of 66. The distinguished Italian Astronomer, M. Plana, died at Turin on the 20th of January.

Mrs. Somerville, now in her 82nd year, has in an advanced state a new scientific work which will doubtless add to her already well-established literary reputation.

Comet VI. of 1863, discovered by Respighi, on December 28, was also found independently by Mr. J. Watson, at Ann Arbor, Michigan, F.S.A., on Jan. 9, of the present year. A correspondent of the *Times*, writing from Edinburgh, stated that he saw this comet with the naked eye in Andromeda on February 7. On that day the comet had ceased to be visible to the naked eye, and was far removed from the constellation in question. The writer (Mr. M. Pringle) no doubt mistook, as many have done before him, the great nebula in Andromeda for a comet. This blunder, scarcely pardonable in the present day, reminds us of the fire-balloon mistaken for a grand meteor mentioned in a recent number of this Journal.

Some Historical Events at the different returns of Respighi's Comet:—

1490.—Parts of Sleswig and Holstein ceded to Frederic, brother of John King of Denmark.—War in the Netherlands.
1543.—Iron cannon first cast in England.—Copernican system of astronomy first published.—War with France.
1597.—War with Spain.—Tycho Brahe leaves his native country.
1650.—Battles of Cromwell.—Civil War in China.
1703.—Bayonets generally introduced.—Wars on the Continent.
1757.—Seven Years' War just commenced.—Battle of Plassey.
1810.—Peninsular War continuing.—Sudden death of the Crown Prince of Sweden.

Superstitious persons and astrologers might find something deep in this!—G. J. W.

A Treatise on Meteorological Instruments.—The increasing interest taken in the science of meteorology renders this publication of Messrs. Negretti & Zambra's a great boon to all those who desire to know something about the construction and use of the principal instruments employed. Barometers—thermometers—wind gauges—rain gauges—with a variety of other instruments whose name is legion—are all clearly described—their purposes indicated—their merits or defects pointed out—the authors by no means confining themselves to their own manufactures, but giving drawings and descriptions of the instruments of other makers. Those who are fitting up meteorological observatories, or even only setting up a simple barometer or thermometer, will find much to interest them in this work.

ASTRONOMICAL OCCURRENCES FOR MARCH, 1864.

DATE.		Principal Occurrences.		Jupiter's Satellites.		Meridian Passage.
		h. m.			h. m. s.	h. m. Venus. A.M.
Tues	1	 1 11 15 10 15 59	Sidereal Time at Mean Noon, 22 38 10·2 ☾ Moon's Last Quarter Occultation of BAC 5866 (6) Reappearance of ditto			9 55·4
Wed	2	15 46 16 21	Occultation of 21 Sagittarii (5) Reappearance of ditto	2nd Tr. E.	13 38	9 56·5
Thur	3	16 51 17 44	Occultation of BAC 6658 (6) Reappearance of ditto			9 57·6
Fri	4	8 53	Conjunction of Moon and Mars, 5° 38′ S.	3rd Ec. R. „ Oc. D.	13 58 44 16 58	9 58·6
Sat	5	8 27	Conjunction of Moon and Venus, 5° 24′ S.	1st Sh. I.	17 49	9 59·6
Sun	6	7 2	Conjunction of Moon and Mercury, 7° 20′ S.	1st Ec. D. „ Oc. R.	15 9 26 18 29	10 0·7
Mon	7	14 30 15 59	Conjunction of Mercury and ι Aquarii, 1m. 1 E. ● New Moon.	1st Sh. I. „ Tr. I. „ Sh. E. „ Tr. E. 2nd Ec. D.	12 18 13 28 14 30 15 39 16 38 34	10 1·7
Tues	8			1st Oc. R.	12 57	10 2·6
Wed	9			2nd Tr. I. „ Sh. I. „ Tr. E.	13 52 13 53 16 8	10 3·6
Thur	10					10 4·6
Fri	11			3rd Ec. D. „ Ec. R.	16 2 54 17 55 55	10 5·5
Sat	12					10 6·5
Sun	13			1st Ec. D.	17 2 54	Moon. — 4 49·0
Mon	14	10 26 18 17	Conjunction of Moon and Uranus, 2° 47′ N. ☽ Moon's First Quarter	1st Sh. I. „ Tr. I. „ Sh. E. „ Tr. E.	14 11 15 18 16 23 17 29	5 40·7
Tues	15	7 36 16 35 17 42	Near approach of Moon to 71 Orionis (5½) Conjunction of Venus and μ Capricorni, 0° 1′ N. Ditto ditto 0m. 2 W.	3rd Tr. E. 1st Oc. R.	12 10 14 47	6 30·9

DATE.		Principal Occurrences.		Jupiter's Satellites.		Meridian Passage.
		h. m.			h. m. s.	h. m.
Wed	16		Sidereal Time at Mean Noon, 23 37 18.5	1st Tr. E. 2nd Sh. I. „ Tr. I. „ Sh. E.	11 56 14 8 16 20 16 29	Moon — 7 19·3
Thur	17					8 5·9
Fri	18	6 58 7 57 9 44 11 4	Occultation of A¹ Cancri (6) Reappearance of ditto Occultation of A² Cancri (6) Reappearance of ditto	2nd Oc. R.	12 51	8 50·7
Sat	19	6 11 7 28	Occultation of ω Leonis (6) Reappearance of ditto			9 34·2
Sun	20					10 16·9
Mon	21	11 20	Near approach of Moon to p^2 Leonis (6)	1st Sh. I. „ Tr. I.	16 4 17 6	10 59·2
Tues	22	22 24	⊙ Full Moon	3rd Sh. E. 1st Ec. D. 3rd Tr. I. „ Tr. E. 1st Oc. R.	11 53 13 24 45 14 6 15 47 16 35	11 41·9
Wed	23			1st Tr. I. „ Sh. I. „ Tr. E. 2nd Sh. I.	11 33 12 44 13 44 16 43	Saturn. — 12 54·7
Thur	24	3 2 11 47 16 18 17 24	Conjunction of Moon and Saturn, 5° 52′ N. Near approach of Moon to 2 Virginis (5) Occultation of BAC 4531 (6) Reappearance of ditto			12 50·5
Fri	25			2nd Oc. R.	15 13	12 46·3
Sat	26					12 42·1
Sun	27	5 32 12 3 12 57 13 5	Conjunction of Moon and Jupiter, 0° 25′ N. Occultation of ω¹ Scorpii (4½) Near approach of Moon to ω² Scorpii (4½) Reappearance of ω¹ Scorpii			12 37·9
Mon	28	13 18 14 16 15 15	Occultation of BAC 5758 (6) Reappearance of ditto Conjunction of Mars and ι Capricorni 2m. 5 E.			12 33·7
Tues	29	10 43	Conjunction of Mars and ι Capricorni, 0° 10′ S.	3rd Sh. I. 1st Ec. D. 2nd Sh. E.	13 42 15 18 19 15 50	12 29·4
Wed	30	10 20	☾ Moon's Last Quarter	1st Sh. I. „ Tr. I. „ Sh. E. „ Tr. E.	12 25 13 20 14 37 15 31	12 25·2
Thur	31			1st Oc. R.	12 50	12 21·0

THE PLANETS FOR MARCH.

Mercury is in the constellation of Capricornus at the beginning, and in that of Pisces at the end of the month. It may be seen in the mornings in the early part of March.

1st.	R.A. 21 19 45	Decl. S.	17 6½	Diameter	6″·0
31st.	„ 0 30 14	„ N.	1 45½	„	5″·0

Venus, which is now approaching nearer to the sun, is on that account less easy to be seen in the morning. It rises about half-past five at the beginning, and about five o'clock at the end of the month, passing from Capricornus into Aquarius.

1st.	R.A. 20 33 41	Decl. S.	18 44	Diameter	13″·0
31st.	„ 22 57 43	„	7 59½	„	11″·6

Illuminated portion of the disc of Venus—0·843.

Mars is still badly placed for observation. It rises about five o'clock in the beginning, and about four o'clock at the end of March, and passes from Sagittarius into Capricornus.

1st.	R.A. 19 46 36	Decl. S.	22 2
31st.	„ 21 19 21	„	16 54½

Jupiter continues in the constellation Libra, rising about three-quarters of an hour after midnight at the beginning, and about half-past ten at the end of the month.

1st.	R.A. 15 41 25	Decl. S.	18 31	Diameter	36″·6
31st.	„ 15 40 18	„	18 23½	„	39″·6

Saturn rises about a quarter before nine on the first, and about half-past six at the end of the month, remaining in the constellation Virgo.

1st.	R.A. 13 7 9	Decl. S.	4 14	Diameter	17″·0
31st.	„ 12 59 37	„	3 23½	„	17″·4
	43″·2		7″·8		

Uranus continues in the constellation of Taurus, and from its great northern declination may still be well observed. It sets about three o'clock in the morning at the beginning, and about one o'clock at the end of March.

1st.	R.A. 5 21 6	Decl. N.	23 18	Diameter	4″·0
29th.	„ 5 22 51	„	23 19½	„	3″·8

THE MINOR PLANETS.

The following are the Minor Planets which will be on, or within one hour of Right Ascension on either side of, the Meridian, between nine and twelve o'clock during the evenings of March. Their places are to be found in the supplement to the *Nautical Almanac* for 1867.

	Magnitude.		Magnitude.
Iris	9·3	Melete	12·5
Egeria	9·9	Concordia	11·6
Calliope	10·4	Asia	·
Themis	10·4	Panopea	12·3
Phocea	11·2	Niobe	10·8
Nysa	9·6	Feronia	—
Hestia	12·6	Galatea	—
Virginia	13·4	Eurydice	—

TABLE OF NEBULÆ.

Right Ascension, Seven and Eight Hours.

NAME OF NEBULA	Right Ascension.	Declination.
45 Hersc. IV. Geminorum	7 21 10	+21 11
A very curious object! a star rendered quite indistinct from enveloping nebulosity.		
39 Hersc. IV. Argo Navis	7 35 40	−14 30½
A pale (planetary?) nebula, in the northern part of a splendid field of stars.		
64 Hersc. IV. Argo Navis	7 35 55	−17 53½
A minute planetary nebula, but so bright as to resemble a star out of focus.		
200 Hersc. I. Leonis Minor.	8 44 20	+33 55
A rather faint fusiform nebula, brightening towards the centre.		

The most interesting objects in the above list are the first and third: 45 Hersc. IV. Geminorum is the southern member of a double star lying nearly vertically in the field: the contrast between the definition of it and its companion is very curious. 39 Hersc. IV Argo Navis is faint and pale; it will be found by a little attention in the northern part of a splendid cluster of stars. 64 Hersc. IV. Argo Navis is a very small planetary nebula; in fact it requires some considerable power to develope its nebulous character, and its intrinsic brightness admits of considerable amplification. 200 Hersc. I. Leonis Minoris lies S.P. and N.F. in the field of view: it is pale and of no great beauty.

ACCIDENT TO LORD ROSSE.—We regret to hear that a serious accident happened to Lord Rosse on the 19th instant, while superintending the felling of some trees at Parsonstown, one of which in falling, struck him and rendered him insensible for a quarter of an hour. It is reported that he is progressing favourably.

THE MIDNIGHT SUN.—In the *Intellectual Observer* for this month will be found an interesting paper by T. W. Burr, Esq., which in addition to a popular explanation of the astronomical causes of the phenomenon, contains graphic accounts of the beautiful effect thus produced in the arctic regions.

CORRESPONDENTS' QUERIES.

H. I.—Has any one noticed the magnitude of the companion to Delta Bootis? Mr Webb, in the *Intellectual Observer* gives it as of the 8½ magnitude: it seems to me brighter than the 8th.

D. T. K.—Can you furnish your amateur readers with a simple, accurate and inexpensive method of getting a meridian line, in order to fix an Equatoreal?

G. J. W.—Was Respighi's comet seen to pass near ρ Orionis about 8h. on the 12th February? as I perceived a faint object near that star with a sweeper of 1·6 aperture.—Cannot Mr G. F. Chambers give us a table of the comets which have appeared since 1861?

J. W.—Where can the tract, 'Eyes and no Eyes,' named by Mr Carrington (No. 13, p. 31,) be procured?

INSTRUMENTS, &c., WANTED.

Sidereal Clock wanted, second hand, in good order. [23

Monthly Notices of the Royal Astronomical Society.—The third Volume wanted: a good price will be given. [26]

The **Astronomical Register, No. 5.**—One Shilling each, in Postage stamps, will be returned for a few clean copies of this number of the Register. [25

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These Notices, which are restricted to *three lines* each, are inserted free of charge to subscribers: applications respecting prices and other particulars to be made to the Editor, with a stamped envelope for reply, without which *no answer can be sent*.—For Advertisements with prices and more complete details, a small charge will be made.

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ASTRONOMICAL REGISTER—*Subscriptions received for the year* 1864—the Editor's list.

To December.—Baxendell, J. Buckingham, J. Dobie, W.H. Frodsham, C. Nasmyth, J. Richard, J.E. **To June.**—Howlett, Rev. F. Main, Rev. R. Reddie, J. Thrustans, J. Welch, J. P. Weldon, Mrs. Williams, G. (Liv.) **To March.**—Bates, Rev. J. C. Jones, W. C. Oldfield, W. Sargent, Rev. J. P. Vallance, P. Virtu, J. Watson, J.

TO CORRESPONDENTS.

The great length of our correspondence compels us to postpone the continuation of Mr Brayley's paper, also that on Spectrum Analysis.—Mr Brodie's letter, and that of 'Analyst' in our next: other papers are deferred.

The letter from RURICOLA is in type, but at the last moment could not be got in by the printer.

ERRATA.——In the table of nebulæ, R.A. 5 hours, by a lapsus calami, θ^1 Orionis is printed for 42 M. Orionis, the proper designation of the nebula surrounding θ^1 Orionis, which is itself a multiple star.

In Mr Reddie's letter, (No 14, p. 38,) paragraph 3, line 2, for '*Earth's* path, at intervals of *a year*,' read the '*Sun's* path at intervals of *half a year*.'—Line 9, for '220 millions,' read '157 millions.'

By an inadvertence, in the report of the Astronomical Society's meeting, (p. 29) the name of the Rev. W. R. DAWES was omitted at the commencement of the 'Further remarks on the envelopes of the Sun.'

CONTENTS.

The Astronomical Register.

No. 16. APRIL. 1864.

SPECTRUM ANALYSIS APPLIED TO THE STARS.

The President of the Royal Society, General Sabine, thus alluded to the researches which have been undertaken on the above subject in his Annual Address, delivered on the 30th November last:—

"The researches of Kirchhoff and Bunsen have rendered it in a high degree probable that we shall be able to obtain much insight into the chemical nature of the atmospheres of the brighter fixed stars, by observing the dark lines in their spectra, and comparing them with the bright lines in the spectra of elementary, and perhaps also of compound, bodies in the state of incandescent gas or vapour. The interest of such an inquiry is obvious, but the difficulties involved in it are very great. The quantity of light coming from even such a star as Sirius is so small, that without the use of a powerful telescope the spectrum obtained would be too faint to bear sufficient enlargement to show properly the fixed lines. The apparent diurnal motion of the star causes much embarrassment, unless the instrument be mounted equatorially, and furnished with a clock movement. The control of the experiments on incandescent bodies requires a thorough knowledge of chemistry, so as to avoid being misled by impurities in the substances examined, and to be prepared to interpret decompositions or combinations which may take place under unusual circumstances, and which may be manifested only by their effects. Nor can the astronomical and physical parts of the inquiry be well dissociated, so as to be separately undertaken by different individuals; for the most elaborate drawings can hardly convey a faithful idea of the various

aspects of the different dark and bright lines, which yet must be borne in mind in instituting a comparison in cases of apparent coincidence. It is fortunate, therefore, that the inquiry has been taken up by two gentlemen working in concert. In a short paper, read to the Society on the 26th of last February, and published in the *Proceedings*, Mr. Huggins and Dr. Miller have described and figured spectra of three of the brighter stars; and this part of the inquiry will doubtless be continued. In a paper since presented to the Society, Mr. Huggins describes the means employed for practically determining with accuracy the positions of any stellar lines which may be observed, with reference to known points of the spectrum, and has given beautiful maps of the spectra of twenty-four of the elementary bodies under the action of the inductive discharge, reserving others for a future communication. When the inquiry is completed, it is possible that we may obtain an amount of knowledge respecting the constitution of those distant heavenly bodies, of which we have at present little conception."

Some account of the results obtained by Mr. Huggins and Dr. Miller will be found in the *Astronomical Register* for April and May, 1863. The second paper by Mr. Huggins, though only subsidiary to the astronomical part of the inquiry, is of the greatest importance. The rarity of some of the metals of which he has mapped the spectra (such as lithium, tellurium, osmium, chromium, barium, strontium, and calcium), and the precautions necessary to insure purity in the specimens used, rendered the experiments most delicate and difficult. One result is so curious that we cannot omit mention of it. In operating on the air spectrum, Mr. Huggins found that a well-marked double line in the blue was common to both oxygen and nitrogen gases, remaining persistent whichever of the atmospheric constituents was passed through the apparatus. There is also a hazy line in the red, which acts in the same way.* Mr. Huggins has also discovered some additional lines in the sodium spectrum, and ascertained that temperature has a marked effect upon the apparatus employed, causing alterations in the position of the lines, which must be allowed for. When Mr. Huggins applies the information thus obtained to his future operations on the stars, the results cannot fail to be of the greatest importance, and we shall eagerly welcome the knowledge of the chemistry of those distant bodies, which his experiments will furnish us with.

T. W. B.

* Mr. Huggins has just ascertained, by further experiments with great dispersive power, that this is a case of almost complete superposition of certain lines in the two spectra of oxygen and nitrogen, which however by extreme care can be distinguished.

ON THE PHYSICAL CONSTITUTION AND INTERIOR HEAT OF THE SUN.

By E. W. Brayley, Esq., F.R.S.

In page 31 of this Journal the remarks I offered at the meeting o the Royal Astronomical Society on the 8th instant are correctly stated. In them, intending to express myself in a general manner, I attributed colloidal *or* crystalline solidity to the pellicle which I suppose to be formed on the photosphere. But further consideration has evinced that it must be the former, or vitreous condition, and cannot be the crystalline, or state of perfect statical solidity. This may seem an unimportant distinction in a case so hypothetical, or perhaps even a futile attempt at an impossible nicety of discrimination, when, as it may justly be contended, all our notions of solar physics must necessarily be expressed in the broadest and most general manner. But we can only study the physics of the sun by applying terrestrial physics to them, and the distinction between the colloidal or vitreous and the crystalline condition of matter is really of much importance in relation to the theory of its constitution. I hope to show, when I am able to resume the subject, how thoroughly the conception of the vitreous solidity of the solid structural elements of the photosphere harmonises with every conceivable view of the processes which are going on in it; and how consistent it is at the same time with the observations of Mr. Nasmyth,* and of other telescopists, who, after him, have recognised the willow-leaves, and also with those of the Rev. W. R. Dawes, especially as described in his paper in the *Monthly Notices* for December 11, 1863.

It does not appear to have been noticed in the recent discussions on the willow-leaves that among the figures of sun spots in Sir John Herschel's *Cape Observations* is one (plate xvii. fig. 9) of a single spot which accurately exemplifies the cases, in which, as described by Mr. Nasmyth, "The spots exhibit the extremities of these leaf-like bodies pointing inwards, and fringing the sides of the cavern far down into the abyss," showing also a slight approach to a radial formation, by "tending" at the edges of the photosphere and of the penumbra "to the average centre of the spot."

* Mem. of Lit. and Phil. Soc. of Manchester, Series III. vol. i. p. 407–411. tof the British Association for 1862, Trans. of the Sections, p. 16. Sir G. Armstrong's Address to the British Association, 1863, p. 10.

This configuration had been previously described by Mr. Dawes, in 1852, by stating that "the interior edge of the penumbra frequently appears extremely jagged; the bright ridges on its surface, which are usually directed nearly towards the centre of the spot, being seen projected to irregular distances on to the cloudy stratum, and looking much like a piece of coarse thatching with straw, the edge of which has been left untrimmed." And in his last published paper, already referred to, he remarks, "After nearly twelve years of careful observations of the same phenomena, I do not think that I could improve upon this description."

Sir J. Herschel's observations, however, were both made and published some years before those of Mr. Dawes. He draws attention (*Cape Observations*, p. 423) "to the remarkable radiated or striated apparent structure of the penumbra in that of fig. 9, an appearance," he continues, "which occurs in many of M. Pastorff's engravings, and which is obviously connected very intimately with the physical cause of the spots." In the figure are some indications also of those variations in brightness of the penumbra to which Mr. Nasmyth has called attention, describing them as "patches considerably brighter than the rest."

It would appear that one important novelty in Mr. Nasmyth's observations is that the "willow-leaf shaped filaments" are, as that designation implies, *lenticular* in outline, former observers having seen, described, and represented them as rectilinear striations only, or as narrow objects bounded by parallel lines; and Mr. Dawes indeed continues so to regard them.

It was not until after the syllabus reprinted above had been prepared, the lecture itself delivered, and this paper written, including the present addition thus far, that I became acquainted with the contents of M. Emile Gautier's article "De la Constitution du Soleil," giving an account of Kirchhoff's work, in the *Bibliothèque Universelle* for November 20th, 1863. The author accepts, generally, Kirchhoff's theory of the constitution of the sun, but suggests a different hypothesis on the spots, which he ascribes to temporary superficial solidifications caused by refrigeration (for which he cannot account) of the sun regarded as an incandescent globe in a state of fusion. It will be sufficient for me to remark in this place that the only point of agreement between his views and mine is, that we both suppose solidification to be effected by refrigeration on the surface of a liquid region of the sun; while our respective applications of that principle to explain solar phenomena, as well as our views of the constitution of the sun, are widely different.

[Mr. Brayley delivered substantially the same lecture at the London Institution on Monday, January 25th.—Ed.]

ROYAL ASTRONOMICAL SOCIETY.

Fifth Meeting, 11th March, 1864.

Warren De la Rüe, Esq., F.R.S., *President*, in the Chair.

Secretaries, Rev. C. Pritchard and Mr. Hodgson.

In noticing the presents, Mr. Pritchard specially referred to Mr. Carrington's work on the *Solar Spots*, recommending it particularly to astronomers, especially the latter part of the book, which was put together in Mr. Carrington's usual concise style, by which six or eight ideas were expressed in half-a-dozen words. There was also an important paper by—not Sir William Herschel—not even his celebrated son Sir John—but by a grandson of Sir William, Mr. Alexander Herschel—a very important pamphlet on *Meteorolites*, to which further reference would be made.

The President stated that it was proposed to give information beforehand of papers likely to be read at the meetings, by an announcement in the *Times*, so that gentlemen might come prepared for the discussions, which it was also intended should be recorded in the same manner as those of other societies.

In answer to a question, whether the information of what was to take place could not be given in the *Monthly Notices*, Mr. Pritchard replied that it would be done when practicable.

A note on a paper, by the late Captain Jacob, on the *Measures of Jupiter and the Satellites*, with the Madras equatorial, was presented by the Astronomer Royal.

On *Two Early Observations of Uranus, by Bradley*, in 1748 and 1750, by Mr. Breen.

Mr. Dunkin on the *Frequent Omission of Readings of the Barometer and Thermometer, in Sextant Observations*. It was too much the case to assume, in these observations, the height of the barometer at 30 inches, and the temperature at 50°. In reducing the observations lately made by Captain Speke, an inattention to this point involved an error equalling sixteen miles in distance. Future travellers should, therefore, be instructed and urged to record, with the sextant observations, the readings of the barometer and thermometer, by which they would not only very much relieve the minds of the computers, but materially add to the value of the observations.

The President said that some excuse must be made for Captain Speke, who was continually being summoned to the presence of the savage chiefs of the country, which considerably interrupted his

observations. It was, however, a very important matter, and ought to be attended to.

On the Distance of the Sun, by Mr. Finlayson. As the periodic time of the Earth's rotation on its axis is to the periodic time of the Moon in its orbit, so is the periodic time of the Sun on its axis to the periodic time of Mars in its orbit. In addition to this, the writer had discovered an agreement between the dimensions of the orbit of the Moon and that of Mars. (Mr. Pritchard said he would undertake that such a paper should not be read before the Society again.)

On Nasmyth's Willow-Leaves, by Mr. Stone. These appearances were observed with the great equatorial at Greenwich, on the 4th of January, in the present year, the whole aperture being used with a power of 100. They have been since seen with the Shuckburgh equatorial of $4\frac{1}{4}$ inches aperture. Mr. Stone considered their size to be about $1\frac{1}{2}''$ to $2''$ in length, and likened them to grains of rice.*

Mr. Dunkin confirmed Mr. Stone's observation, having seen them with the north equatorial, and a power of 40. He had observed hundreds of these small particles, and could see them extending right across the Sun. They had also been observed with the altazimuth instrument of $3\frac{3}{4}$ inches aperture, the field of which is cut up by the transit wires into a number of small squares. 300 of these small bodies occupied one of these squares (about $54''$ in one direction, and $45''$ in the other, or nearly a square minute). This observation was confirmed by Mr. Carpenter. Mr. Dunkin preferred "rice grains" as a description to "willow-leaves." A handful of common rice, let fall gently, would very well represent what was seen.

Mr. Pritchard said that, in justice to the man who, years ago, saw them for the first time, and got no one to second him, it would not be well to alter the name of "willow-leaves."

The President asked Mr. Stone what were the relative dimensions of the mottled appearances in the Sun's disc, and the small particles referred to.

Mr. Stone considered that the mottled appearances were produced by the interlacing of the small particles.

The President said it was a most important confirmation of the observations of Mr. Nasmyth, and that it was clear, from the statements of Mr. Stone and Mr. Dunkin, that when these appearances are once een, they are easily found again by those who know what to look for.

The Astronomer Royal said that Mr. Dawes' admirable comparison of the appearance of the surface of the sun to the edges of *thatching,* more especially at the borders of the spots, was not affected by these statements: the descriptions given by Mr. Dawes were most excellent as to the appearances observable close to the margin of the solar spots.

* See communication from Mr. Nasmyth, *Astronomical Register,* p. 81.

Mr. Drach thought that the peculiar *maritime* atmosphere of this country might account for our seeing the willow-leaves or rice grains, as they have never been observed by Continental astronomers.

A list of *New Double Stars*, discovered by the Rev. W. R. Dawes. This list comprised about fifteen stars observed by the author at different times, some of them very recently. The power used was not above 300.

Mr. Hodgson took the opportunity of stating that he had seen, and thought that any gentleman with a six-inch object glass could see, the small companion (*d*) of Sirius, although it was not exactly in the position given in the diagram in the *Monthly Notices*.

The President confirmed Mr. Dawes' statement that such stars as Sirius were more properly tests of the state of the atmosphere than of the telescope.

On the *Transits of Venus* in 1874 *and* 1882. The Astronomer Royal exhibited a geometrical projection of the earth so that those places might be seen at which the earth's rotation accelerated or retarded the ingress and egress of the planet on the sun's disc, and thus enable favourable localities to be selected for the observing-stations. He first showed that the transit of 1874 would be useless for the purpose of measuring the parallax of the sun, and that for the one in 1882, for observers in the north, no better place than *Bermuda* could be fixed upon, while for those in the south, a tract of country entitled *Sabrina Land* (discovered by Captain Gillis, of the U.S. Navy) was the most desirable spot. But as the transit occurs on the 6th of December, which is very early in the season, it may not be possible to get to the latter place on account of the ice; still it might be a question whether it was not desirable that an expedition should be sent in good time to determine if observations at this spot were practicable.

The President considered that even if a good record of the first and last contacts of this transit should not be obtained by the usual methods, still by means of photographic observation, which he hoped would be greatly multiplied in 1882, the places of the planet at any two points on the disc could be recorded, and by proper measuring the times of ingress and egress could be calculated, so as to aid in the determination of the solar parallax.

Mr. Pritchard referred to Mr. Herschel's pamphlet on *Meteorolites*, and said there was reason to hope that their planetary nature would be proved, the supposition being that by attrition against our atmosphere heat and light were evolved. Mr. Herschel had gone deeply into the subject; and had promised to communicate a paper to the Society at the next meeting; and of the points which it will touch upon, the following is a crude outline. At two stations the time, direction, altitude, and azimuth of these shooting-stars have been

observed, and upon comparing observations they have been enabled to say, with regard to any particular meteor, where it was at the beginning and at the end of its appearance, and thus the length of its path, direction, and velocity are given. The light of these meteors has also been compared with certain stars, and the heat and mass of certain of these bodies have been calculated. Their average velocity seems to be about 30 miles a second. On the 10th of April next a shower of these meteors may be expected, and it would be well that arrangements should be made for observing them. The moment of appearance of a meteor, its altitude and azimuth, and the moment of its disappearance, should be noted at two stations by the best means in the power of the respective observers.

After a discussion as to the best method of obtaining observations of meteors, in which several gentlemen joined, the meeting terminated.

CORRESPONDENCE.

N.B.—We do not hold ourselves answerable for any opinions expressed by our correspondents.

ON THE PHYSICAL CONSTITUTION OF THE SUN.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—On reading Mr. Brayley's *Résumé of the Recent Observations and Researches on the Physical Constitution of the Sun* (ex-companion to the Almanac for 1864), I think some theoretical considerations may account for the possibility of the enormous depth of the internal nucleus-surface below the visible photospheric boundary.

We have hitherto been taught to regard the sun as a homogeneous mass extending from its centre to its visible periphery (say 15′ 30″ semidiameter), and thence find this sphere to be 1,405,000 times the earth in volume. But the MASS is known to be 356,000 times greater; and the theoretic conditions of gravity are still satisfied, if we suppose the internal nucleus to be a smaller and concentric sphere. This would increase the assumed density (1,405 : 356 : : 1 : 0·25,338) say 0·25; and the following table will give some idea of the height of the photosphere above the surface of the solid nucleus, corresponding to the height of the earth's atmosphere:—

A	B	C	D	M N	M P
1	4·0	·62,996	·37,004	280,332	164,668
0·9	3·6	·65,248	·34,752	290,354	154,646
0·8	3·2	·67,860	·32,140	301,976	143,023
0·7	2·8	·70,949	·29,750	312,612	132,388
0·6	2·4	·74,690	·25,310	332,270	112,630
0·5	2·0	·79,370	·20,630	352,306	92,694
0·4	1·6	·85,499	·14,501	380,470	69,530
0·3	1·2	·94,104	·05,896	418,763	26,237

A = Ratio of density of Sun's nucleus to that of the Earth;
B = A divided by 0·25 (the photosphere included);
C = Cube root of the inverse of A; $\frac{1}{4}$, $\frac{1}{3\cdot 6}$, etc.;
D = Unity less C;
M N = C × 445,000 radius of the nucleus in miles;
M P = D × 445,000 height of the photosphere in miles.

It thus appears that M P may be 100,000 miles, and the nucleus-density still be ·57 of the Earth's density, or about thrice that of water.

For it is evident that the diameter must vary as the cube-root of the density; and that we may neglect the mass of the photospheric shell in this approximation.

I am,
Yours faithfully,
S. M. DRACH.

39 Howland Street, Fitzroy Square,
14th March 1864.

THE WILLOW LEAVES ON THE SUN.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—I take the liberty to send you a copy of a letter which I have received from E. J. Stone, Esq., Royal Observatory, Greenwich, giving me an account of his first observation of the "willow-leaf"-shaped objects of which I have discovered the entire luminous surface of the Sun to be formed.

As this authentic confirmation of my discovery of these interesting objects may be acceptable to some of the readers of the *Astronomical Register*, perhaps you will be so good as to give Mr. Stone's letter a place in your next number, as I have his permission to send you the enclosed copy for that purpose. Mr. Stone's description of the willow-leaf-shaped objects as "bright rice-like particles," I readily accept as conveying a very good general impression of their form and aspect, but I still prefer the comparison with the willow leaf, as I consider rice grains rather too blunt-ended; but had the comparison as made by Mr. Stone happened to occur to me when I first saw those objects, I daresay I might have as readily accepted it, being sufficiently near for identification.

I am, yours very faithfully,
JAMES NASMYTH.

Penshurst, Kent, March 9, 1864.

Copy of a Letter from E. J. Stone, Esq. to James Nasmyth.

Royal Observatory, Greenwich, Feb. 25, 1864.

Dear Sir,—The Astronomer Royal has placed in my hands your letter of the 20th February.

Your discovery of the "willow leaves" on the Solar Photosphere having been brought forward at one of the late meetings of the Royal Astronomical Society, my attention was attracted to the subject.

At my request, the Astronomer Royal ordered of Mr. J. Simms a reflecting eye-piece for our great equatorial. The eye-piece was completed about the end of January last, and at the first good opportunity, I turned the telescope on the Sun.

I may state that my impression was, and it appears to have been the

impression of several of the assistants here, that the willow leaves stood out dark against the luminous photosphere.

On looking at the Sun, I was at once struck with the apparent resolvability of the mottled appearance of the Sun, the whole disc, so far as I examined, appears to be covered over with relatively bright rice-like particles, and the mottled appearance seemed to be produced by the interlacing of these particles. I could not observe any particular arrangement of the particles, but they seemed to be more numerous in some parts than in others.

I have used the word rice-like particles merely to convey a rough impression of their form. I consider them something like the figure 0. I have seen these rice-like particles on two occasions since, but not so well as on the first day, when the definition was exceedingly good. Yesterday, Feb. 24, I saw them for a few minutes, but with great difficulty.

I use the full aperture, 12¾, and a low power.

I am, Dear Sir, yours very truly,

E. J. STONE.

P.S.—On the first day that I saw them, I called Mr. Dunkin's attention to them; he appears to have seen them, and considers the figure above to represent them fairly. He says however, that he should not have noticed them, if his attention had not been called to them.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—It is with some diffidence that I venture to ask you to insert the inclosed memorandum, which I made on Saturday, March 12:—

"Went to the R.A.S. last night: the willow-leaves question was under discussion. It seeming to be the impression of speakers that, once knowing what to look for, they were not difficult to find, I turned telescope on Sun at 8 a.m., and, after steady gazing for a few moments at one place, I saw, or at any rate fancied I saw, the rice-like appearances, to use Mr. Stone's description. They were not visible continuously for long, but only by glimpses; there were particles of scud flying about, and perhaps this is only what might have been expected."

The telescope employed was a 3-inch refractor, by Cooke, charged with a power of 42. The Greenwich observers have seen the phenomenon with a 4-inch refractor, so this renders it not improbable that the so-called willow-leaves really were seen. Professor Frankland had been lecturing on the subject at the Royal Institution the previous week, so that I was tolerably well primed in knowing what to look for.

Your obedient Servant,

G. F. CHAMBERS.

March 19, 1864.

THE SUN'S MOTION IN SPACE.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—I am obliged to "Nauticus" for his friendly remarks, but not less so to "D.," for his adverse arguments. To save your valuable space, I have numbered the paragraphs of "D.'s" letter, and the subsequent paragraphs of this communication, to facilitate future reference.

1. As regards par. 1 of "D.'s" letter, I think he must yet confess that I indulge in nothing "fanciful." "The test of observation" (in par. 2) I accept. I agree with paragraphs 3 and 4, except the last two lines, in which "D." draws a false conclusion from his own premises, as probably he has already discovered. But, since his argument stands on record, I must answer it.

2. Suppose, therefore, the sun to be at rest, and that *Jupiter* revolves round it, with a mean velocity of 29,000 miles an hour; also that his 2nd satellite revolves round him with a mean velocity of 32,000 miles an hour. Then, doubtless (according to "well-known mechanical principles and the necessities of the laws of space and motion,") the satellite *must* move, when it is being eclipsed at the rate of 29,000 + 32,000=61,000 miles an hour *direct*, and during a transit at the rate of 29,000 − 32,000=3,000 miles an hour *retrograde*. So far, I beg leave to assume that "D." goes with me; as I am merely quoting what he himself truly says, though he puts it forward only as an *argumentum ad hominem* against me.

3. But he adds (par. 4):—"Therefore, the time occupied by the transit of the satellite should be somewhere about twenty times that occupied by the occultation." To this (as I have hinted) I feel it is almost unnecessary to reply. It would only be true were *Jupiter* at rest; which is against "D.'s" own supposition, upon which the satellites' actual varying velocities are based. "D." has inadvertently overlooked the effect of Jupiter's own proper motion; and forgotten that *the time* of the occultation or transit only indicates the *apparent* and *relative* motions of the planet and satellite: i. e., the time in which they cross one another.

4. I therefore pass over par. 5 of "D.'s" letter, and come to par. 6. There he says:—"It appears, then, that Mr. Reddie must either deny Jupiter's orbital motion, for precisely the same reasons as led him to conclude the Sun to be motionless, or [admit] that he has misapplied the 'well-known mechanical principles, and the necessities of the laws of space and motion.'" Now, I do not take advantage of the error in reasoning already noticed, upon which the first of these alternative propositions is based; but will frankly admit that there is a fair analogy between the Solar System with a moving Sun, and the motions of Jupiter and his satellites. I assume, also, that "D." will now give up his second proposition, taking for granted that (assuming his own data in par. 3) he now sees that the real motions of Jupiter's second satellite *must* differ precisely by 58,000 miles an hour, during an occultation and transit respectively, and that these greatly varying velocities are *confirmed* by "the test of observation."

5. But should "D." not admit these assumptions, then I would beg leave to turn his own argument against himself, thus:—If Jupiter's real motion be 29,000 miles an hour direct, and we suppose the real motion of his 2nd satellite during an occultation to be 32,000 in the same direction—then, the apparent and relative velocity of the satellite (i. e. the rate at which it will pass behind the planet), will be only 3,000 miles an hour direct; whereas, if during a transit, while Jupiter is moving at the rate of 29,000 miles an hour *direct*, we suppose his satellite really to move at 32,000 *retrograde*,—then (to apply the test of observation) the apparent speed with which they would cross one another would be 29,000 + 32,000 = 61,000 miles an hour; and, in that case, the eclipse would certainly occupy twenty times the period of the transit. The latter would be over in little more than one hour, the occultation would take more than 20 hours. But the "test of observation" refutes these absurd suppositions and their results, and proves what "D." had questioned.

6. The analogy adduced by "D." is nothing new to me. In a paper on this

subject, which I submitted to Section A of the British Association this year, I said,—"The motion of the moon round the earth, as it moves in its orbit round the sun, is analogous to the motion of the earth round the sun, if the sun moves in space."* But I forbear, at present, to open up a fresh "moon controversy" in the *Register*. In my former letter I only noticed a few very salient points, in order to induce others *to think*.

7. If "D." had said that such immensely varying angular velocities as those of Jupiter's satellites are thus shown to be, while revolving round their primary and but slightly varying their respective distances, cannot be reconciled with the current dogmas of physical astronomy, any more than the varying velocities of the earth, if the sun moved in space, to which I have objected, I could not have gainsaid the proposition. But the *facts* as to the motions of Jupiter's satellites being what they are,—assuming "D.'s" own data, and applying his own test,—I trust that he is not prepared to say, "So much the worse for the facts," and to cling to irreconcilable theories.

8. "D." should also recollect, that the motions of Jupiter and his satellites, like those of all the other planets and satellites and the comets, would themselves be greatly complicated and confused by the motion of the sun as their centre. Their old aphelion and perihelion velocities would all be upset if the sun so moved; and all the elliptical orbits converted into complicated, impossible paths, that could only be characterised as *Vermicular*. For simplicity and clearness, I have chiefly argued only as to the earth and moon. To do more, would be like attempting to explain the *obscurum per obscurius*. After all, we do know somewhat more of this dull earth than of Jupiter and his satellites. These may whirl about in looped curves, with alternate points of rest and great velocity, and yet continue, as we see they do, in the heavens. But what would happen if this massive earth were thus arrested in its orbit, or had its velocity reduced by 36,000 miles an hour? Moreover, *what* could so reduce its velocity; or, if reduced, cause it afterwards to increase, so as to enable it to get round the flying sun?

9. In conclusion, I would beg "D." and others to observe, that, at last,—after a life-long adherence to this ill-considered theory, the Astronomer Royal now admits it to be fraught with doubt and uncertainty, and confusion. I will only add, in answer to "D.," that "Nauticus" rightly apprehends my meaning as to the probable effect of upheavals and depressions of the earth upon astronomical observations. It will be natural to think them inadequate. I, too, was taught, as a child, that even the earth's whole orbit is "only as a point," with reference to the fixed stars; but as a man, "I don't believe it." *Credite posteri?*

Yours faithfully and obliged,
J. REDDIE.

Hammersmith, March 7th, 1864.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—I think the cause why the compound movements of the heavenly bodies and the computed great velocities are not comprehended by many, is the not considering them as *physically connected*. We find no difficulty in travelling in a railway train to the East at the rate of 50 miles an hour, and, conceiving that the circumference of our globe is moving at the same time at the rate of 1,000 miles an hour, and the globe itself at a still much greater velocity. Even were we in a car of a balloon the effect would be the

* Vide "Victoria toto Cœlo; or, Modern Astronomy Recast," § 57. (Hardwicke.)

same. As the earth, its atmosphere, and the moon are wrapped together, and these again embraced in the solar atmosphere, the individual bodies of the system are not exposed to the resistance and friction of the surrounding medium. H.

14th March.

TELESCOPES WITHOUT TUBES.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—I find in the February number of the *Register* (page 29), a notice of a paper read by Mr. Nasmyth before the R.A.S. on Solar Phenomena, in which the following words occur, "he had in hand a 12 in. glass reflector, which he proposed to use *without a tube*, for observing the sun's disc, *as he considered the tube to interfere with definition.*"

If this should meet his eye, or that of anyone of his opinion, would he or they kindly furnish an explanation, as most of us, I fancy, since the days of the old aërial telescopes, have been taught a different and opposite opinion.

I am, Sir, truly yours,
Dublin, March 1864. JOHN M. STOTHARD.

SHOOTING STARS.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—In your last number you inserted a letter from Mr. A. S. Herschel upon Shooting Stars. Allow me to offer a few remarks upon this subject so closely connected with Astronomy. It is the opinion of some that these bodies, and meteors generally, are at a considerable distance from the earth, and also that they are composed of solid matter. I have reason to doubt this, and think that very frequently they are dependent upon conditions of atmosphere or gases held in suspension in the atmosphere.

Many years ago I noticed in the harbour of Valentia, in Ireland, one dark night, a small meteor pass over the harbour; the length of its path possibly half a mile, its altitude about 200 or 300 feet. I judged it to be upwards of a mile distant from me. It was not very bright.

Again, in 1855, I was crossing the Alps, by the pass of the Mount Cenis, in the middle of December, and I was astonished at the number, the brilliancy, and apparent proximity of the small meteors. They so illuminated the inside of the diligence in which I was travelling, that, so far as my recollection serves me, I could have read large print. The windows were frozen over, so that I could not observe them as I should have wished, and the frost was so intense, that my moustache was a mass of icicles if exposed to the air for two minutes. These meteors occurred principally at about the highest part of the pass, 6,700 feet above the sea, which we passed about two hours after midnight. So far as I can remember they did not pursue any set direction, from or to any cardinal point, but appeared promiscuously from all points of the compass.

Regarding the proximity of larger meteors, I would notice one that I saw in June 1863. It was about half an hour before sunset, the sun shining

brightly. I noticed a brilliant meteor passing from west to east, the nucleus about one-sixth the diameter of the moon, but much brighter, and having a long tail of sparks diverging somewhat from the nucleus; its rate of progression was *moderately slow.* What made the meteor so conspicuous was, that its path was projected across a bank of dark gray cumulus cloud; this cloud I estimated at not more than four miles from my position, and the meteor *apparently* was nearer to me than half that distance, and its length from the earth might have been 700 feet, more or less. I heard no noise whatever; its path was parallel to the surface of the earth. It continued visible for three or four seconds, during which time it passed over an azimuth of about 15°. I offer these facts to your readers who take an interest in Meteorology for their consideration, hoping that they may prove interesting, if not useful.

I beg to remain, Sir,
Yours obediently,
FREDERICK BRODIE.

Uckfield, Sussex.

THE MOON CONTROVERSY.

[In consequence of the large number of letters received on this subject, we have postponed the whole until our next number, excepting the two following, which were omitted from our last.—Ed.]

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—In the compass experiment proposed by "A. L. S.," the path in space of the needle-points, North (N) and South (S), may be analytically determined as follows:—

Let A denote the point of the axis upon which the needle is suspended, and which divides it into two portions e and e', North and South respectively: the oscillations of the needle-points in circular arcs are expressed by the equations $x_{,}=e\cos\lambda$, $y_{,}=e\sin\lambda$, and $x_{,,}=e'\cos\lambda$, $y_{,,}=e'\sin\lambda$, for the N. and S. points respectively.

The orbit of A round the apple is expressed by the equations $x=a\cos\phi$, $y=a\sin\phi$, and the equations of the curves in space described by the needle-points are

$x_{,}=a\cos\phi+e\cos(\phi+\lambda)$, $y_{,}=a\sin\phi+e\sin(\phi+\lambda)$ and
$x_{,,}=a\cos\phi+e'\cos(\phi+\lambda)$, $y_{,,}=a\sin\phi+e'\sin(\phi+\lambda)$.

As the needle maintains its parallelism when carried round the table, then $y_{,}=y_{,,}$; therefore $e\sin(\phi+\lambda)=e'\sin(\phi+\lambda)$ whatever values e and e' may have, hence $\sin(\phi+\lambda)=o$, or $\phi+\lambda=o$, therefore $\lambda=-\phi$.

The conclusion therefore is inevitable that "Cyclops" is right in stating that two counteracting movements are required to produce parallelism in a curve: in this instance, one round the apple or centre of the table, and another round the pivot or centre of the card. Perhaps a casuist might quibble whether the card rotates on the pivot, or the point turns under the card! But in this case of parallelism, I am convinced from the above demonstration of $\lambda=-\phi$ that there are two distinct movements—1st, a revolution ϕ, and 2nd, a rotation λ equal and contrary to the revolution, consequently this is *not* a case of non-rotation as "A. L. S." asserts, and as I myself once supposed, in common with most mathematicians.

I remain, Sir,
Your obedient Servant,
AN ANALYST.

16 Feb. 1864.

A FEW MARE'S NESTS.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—I really must congratulate your correspondents Messrs. "J. Reddie," "Readingensis," and "Enquirer," upon the discovery of some of the finest specimens of equine nidification which it has lately been my lot to encounter. A few lines may suffice to exhibit their nature.

Imprimis, some simple considerations may tend to obviate the "delightful confusion," which seems to obtain in Mr. Reddie's mind, between relative and absolute motion. It seems to have escaped his notice that the centre of the planetary motion is *the centre of gravity of the Solar System*; and that the transference of this in space cannot in the slightest degree affect the revolution of the planets round it. An experiment which will cost Mr. Reddie two-pence may make this clearer. Let him invest a penny in a tennis ball, and, attaching a piece of string to it, whirl it round his hand as he stands or sits in his own room. The hand will represent the sun, the ball any one of the planets—say our own earth—the string the centripetal tendency, the centrifugal tendency being generated by the whirling motion. Having satisfied himself that the motion of the ball on *terra firma* is equable, let him walk down to the nearest pier on the Thames, and lay out his second penny on a ride on a steamboat. If he will only repeat his experiment upon the deck or in the cabin, he will, I think, soon ascertain that the ball will revolve round his hand, *cæteris paribus*, at precisely the same rate and the same manner as it did at Hammersmith, whether he whirl it in a "fore-and-aft" direction, or "athwart-ship."—With reference to his notion as to the error in the Stellar parallax. It contains a germ of truth; but not the *whole* truth. What he says would be strictly and literally correct, if *two* measures only of the parallactic displacement of a fixed star were made—one on the 1st of January and the second on the 1st of June. If he will draw on a piece of paper an ellipse to represent a foreshortened view of the earth's orbit, and at some distance put a dot to indicate the star whose parallax is to be determined, he will see that, although the parallactic displacement calculated on the supposition that the earth's orbit is fixed in space, would in June err monstrously in *defect*, yet that a third observation made on the succeeding 1st of January would err precisely in the opposite direction, i.e., in *excess*, so that the two errors would exactly balance each other. Mr. Reddie seems ignorant that the *whole* of the proper motions of a star are discussed in computing its parallax. Finally, his wonderful notion touching the upheaval and depression of the land would seem to indicate that his geological acquirements are even beneath his astronomical ones, inasmuch as any change of level in the earth's surface sufficient to disturb stellar parallax must instantly and inevitably result in (or rather consist of) the entire destruction of our globe itself.

With reference to "Readingensis," he really writes as though light were some material substance which could be weighed or measured. Who told him that "the 'Solar System' was floating in a sea of light"? Does he know that light is *utterly invisible*? If not, let him read the report of the British Association for 1863, when he will find the description by the Abbé Moigno of a very ingenious little instrument called the Tenebroscope, to illustrate this fact. Were "Readingensis" shut up in a dark room, and the rays of the sun admitted through a small hole in the shutter, he would doubtless tell us that he saw the light, just as he says that "we see the beams darting through the clouds." It is the illuminated particles of dust, "Readingensis," and *not the light at all*, which you see! I need not fill your pages, Sir, with a list of books on optics or natural philosophy. Almost

any of those more recently published would give "Readingensis" the exceedingly elementary information which he seems to require, and the study of them may possibly diminish the *cacoëthes scribendi* in him. The last sentence in his letter I confess myself utterly and entirely unable to understand.

Finally, we come to "An Enquirer," and his suppositious lunarian (or lunatic); who would certainly justify his claim to the last appellation, if he adopted "An Enquirer's" mode of determining the fact of the moon's rotation. If "An Enquirer" were seated in a railway train, and upon a parallel line of rails another train were travelling in the same direction, and at the same rate, "Enquirer" would hardly refer to *that* to test whether he himself were moving or not. He would, of course, direct his glimpse to the *landscape*. So with an inhabitant of the moon, who would legitimately turn his telescope upon the *fixed stars*, which he would see rise and set (albeit more slowly) in the same manner as we do. How comes it (I might retort upon "An Enquirer") that, if the moon does not rotate on her axis, the whole face of the heavens does not appear stationary to our satellite? I could have said much more upon this founding of astonishing theories upon the ignoring of the very elements of physical sciences, but feel that I have already trespassed too far upon your valuable space.

I am, Sir, Your most obedient Servant,

13th February 1864. RURICOLA.

DOUBLE STARS.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—In case Admiral Smyth should not himself solve the difficulty which your correspondent, Mr. George Hunt, has found with respect to the supposed duplicity of α (*alpha*) *Arietis*, I beg leave to state that it is simply a typographical error for ϵ (*epsilon*) *Arietis*. Such errors are so wonderfully rare in the Admiral's valuable and interesting "Cycle," that it is perhaps not very surprising that it should be almost presumed that there are none. Lest similar difficulty should be experienced in another case of the same kind, I may mention that on page 300 of vol. i. (the *Prolegomena*), line 16 from the bottom, for η (*eta*) *Ophiuchi* should be read *p* (or 70) *Ophiuchi*.

Mr. Wm. Wray enquires about a close double star in *Taurus*. It is Σ 749; P=23°·45 (or 203°·45); D=0″·670; epoch 1829·48; mag. 7.1; 7·2. I cannot find that it has been observed elsewhere; but if Mr. Buckingham's measured distance is sufficiently correct, there seems to be ground to suspect an increase of distance.

Mr. Frederick Bird's new double star, following *Procyon* at a distance of about 5½ minutes of arc (rather too respectful a distance for a *companion*), has been seen decidedly separated with my 8¼-inch O.G. on two occasions, but both of them were sadly unfavourable. With power 407, I estimated P=195° ±; D=0″·6 ±. At best the vacancy between the disks was not more than ¼th or ⅓rd of the diameter of B. There seems good ground for concluding that it must have come out of late years. Curiously enough, in looking from time to time for Admiral Smyth's lost star, between this little double and *Procyon*, I have always carefully shut out both by using a small field, lest the light even of the 8½ mag. star should incommode the eye. The very faint point at a large angle *n.p.* (345° ±) I estimated of mag. 11·8. It is just steadily visible with my 8¼-inch glass.

I remain, Sir, yours very truly,

W. R. DAWES.

Hopefield Observatory, Haddenham, Bucks, March 18, 1864.

NOTES AND GLEANINGS.

Comet V. 1863.—The following elliptic elements have been computed by M. Michez, of Padua:—

P.P	=	1863 Dec. 27. 035.	G.M.T.
π	=	59 40	
Ω	=	304 52	
ι	=	63 56	
q	=	0· 7,682	
ϵ	=	0· 96,628	
Motion.		Direct.	
Period	=	108·76 years.	

The noticeable feature in these elements is that they assign a period of revolution exactly double that required by the supposition that the comet is identical with that of 1810. Identity with the comet of 1490 is, however, still by no means improbable. The interval of 320·1 divided by 3 gives 106·7, sufficiently near 108·7 under the circumstances. Further computations, from a longer series of observations, may be looked for with interest.

Comet VI. 1863.—The comet discovered by M. Bäcker, in October last, is still visible.

For Berlin mean noon.

1864		R.A. h. m. s.		Decl. ° ′
April 1	…	20 30 9	…	+12 32·0
„ 2	…	20 30 32	…	12 24·0
„ 3	…	20 30 54	…	12 16·0
„ 4	…	20 31 14	…	12 7·9
„ 5	…	20 31 33	…	11 59·8
„ 6	…	20 31 50	…	11 51·7

The brightness on April 2 will be 0·75 of what it was when discovered, so that it is still well within range. During the above period, the comet will move from near β towards ι Delphini, stars of the 4th and 5th magnitudes respectively.

The Weather of 1863.—During the year 1863 the weather was, upon the whole, favourable to the public health in rural districts, and especially to the products of the soil. Very fine weather prevailed during both hay and corn harvest, and the crops were secured in excellent condition. The crop of fruit was also abundant and of good quality. The mean temperature of the year was half a degree above, and the fall of rain three inches and a half below, the average. The most remarkable features of the year were the unusual mildness of the winter of 1862-3; the very great barometric pressure throughout the month of February; the fine dry weather during the months of July and August; the unusual phenomenon of frost on the morning of July 12th; add the frequent very severe gales of wind during the autumnal months.—*Mr. Prince's Meteorological Journal.*

New Minor Planet.—In Le Verrier's *Bulletin International* of March 17, there appears the substance of a communication from Mr. Pogson, of Madras, forwarded by Mr. Hind. During the month of February, Mr. Pogson had been following, as he thought, the planet Concordia, but he subsequently found the observations differed so largely from the ephemeris as to make it clear that he had found a new planet. To it he proposes to assign the name Sappho. It appears to have been first seen on February 2. Its designating number will be 80.

ASTRONOMICAL OCCURRENCES FOR APRIL, 1864.

DATE.		Principal Occurrences. h. m.		Jupiter's Satellites.	h. m. s.	Meridian Passage. h. m. Saturn.
Fri	1		Sidereal Time at Mean Noon, 0 40 23·3	2nd Ec. D.	13 35 27	12 16·8
Sat	2	5 57	Conjunction of Moon and Mars, 6° 45′ S.			12 12·6
Sun	3	5 36	Superior Conjunction of Mercury	2nd Sh. E. „ Tr. E.	10 57 12 35	12 8·4
Mon	4	5 53	Conjunction of Moon and Venus, 6° 18′ S.			12 4·1
Tues	5			1st Ec. D.	17 11 56	11 59·9
Wed	6	1 49 10 4	● New Moon. Conjunction of Moon and Mercury, 3° 1′ S.	1st Sh. I. „ Tr. I. „ Sh. E. „ Tr. E.	14 18 15 6 16 31 17 17	11 55·7
Thur	7			1st Ec. D. „ Oc. R.	11 40 24 14 36	11 51·5
Fri	8			1st Sh. E. „ Tr. E. 2nd Ec. D.	10 59 11 44 16 9 16	11 47·3
Sat	9			3rd Oc. D. „ Oc. R.	11 1 12 40	11 43·0
Sun	10	8 38 20 22	Conjunction of Mars and ι Aquarii, 9m. 0 E. Conjunction of Moon and Uranus, 3° 1′ N.	2nd Sh. I. „ Tr. I. „ Sh. E. „ Tr. E.	11 12 12 41 13 32 14 55	11 38·8
						Moon.
Mon	11	6 28 7 38 11 13 18 5	Occultation of χ² Orionis (6) Reappearance of ditto Near approach of Moon to χ³ Orionis (5) Conjunction of Mars and μ Capricorni, 8m 4 W.			4 21·9
Tues	12					5 12·1
Wed	13	12 9	☽ Moon's First Quarter	1st Sh. I. „ Tr. I.	16 12 16 52	6 0·1
Thur	14			1st Ec. D. „ Oc. R.	13 34 6 16 22	6 45·9
Fri	15			1st Sh. I. „ Tr. I. „ Sh. E. „ Tr. E.	10 40 11 18 12 52 13 29	7 30·0

DATE.		Principal Occurrences.		Jupiter's Satellites.		Meridian Passage.
		h. m.			h. m. s.	h. m.
						Moon
Sat	16	 12 14	Sidereal Time at Mean Noon, 1 39 31·6 Near approach of Moon to 14 Sextantis (6)	1st Oc. R. 3rd Ec. D. „ Ec. R. „ Oc. D. „ Oc. R.	10 48 11 52 11 13 45 18 14 25 16 4	— 8 12·8
Sun	17	12 13 13 19 14 15 15 15	Occultation of BAC 3726 (6) Reappearance of ditto Occultation of 55 Leonis (6) Reappearance of ditto	2nd Sh. I. „ Tr. I. „ Sh. E.	13 48 15 0 16 9	8 55·2
Mon	18					9 37·7
Tues	19			2nd Oc. R.	11 20	10 21·1
Wed	20	6 27 8 40 9 48	Conjunction of Moon and Saturn, 6° 3′ N. Occultation of *g* Virginis (6) Reappearance of ditto			11 6·2
Thur	21	13 19	⊙ Full Moon	1st Ec. D.	15 27 53	11 53·6
						Saturn.
Fri	22	9 23 10 25 19 17	Occultation of BAC 4896 (6) Reappearance of ditto Conjunction of Mars and σ Aquarii, 2m. 9 W.	1st Sh. I. „ Tr. I. „ Sh. E. „ Tr. E.	12 34 13 3 14 46 15 14	— 10 48.4
Sat	23	7 48 12 51 14 7	Conjunction of Moon and Jupiter, 0° 34′ N. Occultation of λ Libræ (6) Reappearance of ditto	1st Ec. D. „ Oc. R. 3rd Ec. D.	9 56 17 12 33 15 49 47	10 44·2
Sun	24			1st Sh. E. „ Tr. E. „ Sh. I.	9 14 9 40 16 22	10 40·0
Mon	25					10 35·8
Tues	26			2nd Ec. D. „ Oc. R.	10 34 42 13 36	10 31·7
Wed	27			3rd Tr. E.	8 56	10 27·5
Thur	28	16 34	☾ Moon's Last Quarter	2nd Tr. E.	8 38	10 23·3
Fri	29	16 15 17 18 22 10	Occultation of C^1 Capricorni (6) Reappearance of ditto Greatest Easterly Elongation of Mercury 20° 43′	1st Sh. I. „ Tr. I.	14 27 14 47	10 19·1
Sat	30	15 31 16 33	Occultation of κ Aquarii Reappearance of ditto (5)	1st Ec. D. „ Oc. R.	11 50 10 14 17	10 15·0

THE PLANETS FOR APRIL.

Mercury becomes visible again as an evening star towards the end of April, setting about half-past nine on the last day of the month. It passes from Pisces into Taurus.

1st.	R.A. 0 37 27	Decl. N. 2 40	Diameter	5″·0
30th.	„ 3 53 23	„ 23 0½	„	8″·2

Venus, approaching nearer to the sun, gets into a worse position for observation. This planet, however, may be detected when very close to the sun, with a good telescope, in the daytime. It passes from Aquarius into Pisces—rising about five o'clock at the beginning and four o'clock at the end of the month.

1st.	R.A. 23 2 19	Decl. S. 7 33	Diameter	11″·4
30th.	„ 1 13 24	„ N. 6 5	„	10″·6

Illuminated portion of the disc of Venus—0·907.

Mars rises about four o'clock in the morning on the 1st, and about three o'clock on the 30th of April, passing from Capricornus into Aquarius.

1st.	R.A. 21 22 22	Decl. S. 16 41½
30th.	„ 22 46 57	„ 9 26

Jupiter rises about half-past ten in the evening at the beginning, and about half-past eight at the end of April, continuing in the constellation of Libra. It will arrive at opposition next month, but its great southerly declination renders it somewhat unfavourably situated for observation.

1st.	R.A. 15 40 4	Decl. S. 18 22½	Diameter	39″·8
30th.	„ 15 29 2	„ 17 43½	„	42″·0

Saturn arrives at opposition on the 4th of the month—remaining in the constellation Virgo. It rises about half-past six on the first, and about half-past four at the end of the month.

1st.	R.A. 12 59 20	Decl. S. 3 21½	Diameter	17″·4
30th.	„ 12 51 27	„ 2 33½	„	17″·2

Dimensions of Ring—Outer major axis, 43″·4. Outer minor axis, 7″·3.

Uranus may still be seen in Taurus, setting about one o'clock in the morning at the beginning, and about eleven in the evening at the end of the month.

2nd.	R.A. 5 23 20	Decl. N. 23 20	Diameter	3″·8
30th.	„ 5 28 4	„ 23 24	„	—

THE MINOR PLANETS.

The following are the Minor Planets which will be on, or within one hour of Right Ascension on either side of, the Meridian, between nine and twelve o'clock during the evenings of April. Their places are to be found in the supplement to the *Nautical Almanac* for 1867.

	Magnitude.		Magnitude.
Iris	9·4	Nysa	10·0
Thetis	9·7	Hestia	12·4
Calliope	10·3	Virginia	13·3
Phocea	10·7	Europa	10·6
Urania	10·7	Danae	12·3
Circe	11·6		

TABLE OF NEBULÆ.

Right Ascension, Nine Hours.

NAME OF NEBULA	Right Ascension.	Declination.
205 Hersc. I. Ursæ Majoris	9 12 50	+51 34½
Tolerably bright, of an elliptic form, condensing towards the centre.		
137 Hersc. I. Lyncis	9 16 5	+35 5½
Very small and pale, yet with faint traces of central condensation.		
57 Hersc. I. Leonis.........	9 24 30	+22 5½
A large and rather bright, though diffused nebulous mass.		
78 Hersc. I. Ursæ Majoris	9 37 15	+72 54½
A nebula of some size, but dim and uninteresting.		
81 & 82 M. Ursæ Majoris	9 44 20	+69 45
Two very fine bright nebulæ: 81 M. condenses rapidly, and has a nucleus apparently almost stellar. 82 M. is long, narrow, and bright, without any particularly apparent nucleus.		
286 Hersc. I. Ursæ Majoris	9 51 35	+69 23½
A round nebula, dim, faint, and pale.		
163 Hersc. I. Sextantis ...	9 58 30	− 7 4
Small, bright, and somewhat elongated, the nucleus at times appearing almost stellar.		

Few of the nebulæ in the Ninth Hour of Right Ascension call for any special remark; the second and sixth objects on our list are almost overpowered by neighbouring stars. In gazing at 57 Hersc. I. Leonis there is a suspicion at times of a double nucleus, but the impression is not persistent. 81 and 82 Messier form a curious and interesting pair—81 shews faint indications of resolvability; it lies across the field of view in a NP and SF direction, and to an averted eye the nucleus appears almost stellar in its character. 82 M. is some half a degree north of 81; it is fusiform, long, narrow, and bright, but without any especially apparent nucleus. With a low power these two nebulæ form a beautiful field. Of 163 Hersc. I. Sextantis Sir William Herschel wrote that with six inches of aperture on his 20 foot reflector he could "scarcely perceive" it. It must have increased astonishingly in brilliancy since, as with a refractor of 4·2 inches aperture it is now seen as a bright and rather elongated nebula, condensing so rapidly as to give almost a stellar appearance to its nucleus.

Comet VI., 1863.—It appears, from a communication to *Silliman's* (American) Journal, that this comet was observed by a Mr Hovey, of Southville, New York, on the 21st November, more than a month before it was seen elsewhere. It appeared as large as a third magnitude star, and, with its tail, was well visible without a glass.—*Reader.*

The Moon.—A very interesting Chart of the Moon's phases has just been published by Messrs Smith and Beck, illustrated with nine of Mr De La Rue's excellent photographs, and in addition, various tables, in which the size, distance, orbit, etc., of our satellite are given. There is an explanation of the libration, and a small index chart, by which the names of the various craters, etc., seen on the photographs, may be learned. The whole would certainly prove useful to those interested in the "Moon Controversy."

THE NEW DOUBLE STARS.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—The little star following *Procyon* about 22s., and 0′·7 to the north, was I think seen double first by Mr F. Bird. With Mr J. G. Barclay's 10 inch refractor I divided it clearly, with powers from 220 to 750. I determined on

March 14: P = 134° 9′ D = 0″·55

The stars are respectively of mag. 9·5 and 9·8. This star was often observed in connexion with Procyon by W. Struve with the Dorpat, and by Otto Struve with the Pulkowa refractor, but I am not aware that it was seen double by either instrument.

The small star preceding Procyon a little to the north, discovered by Mr Barclay in 1856, will serve well for a test of illuminating power; I determined its position in reference to Procyon—

1863, March 23: P = 294° 47′ D = 46″·9
1864, March 19: „ 296 5 Mag. 10.

The small star referred to by Mr Wray in your last number is to be found in Struve's great work under No. 748. He gives the following measures:

(Mean) 1829·48: P = 23°·45 D = 0·670 Mag. 7·1, 7·2.

My own measures give—

(Mean) 1864, March 16·7: P = 186° 58′ D = 0·807 Mag. 7·4, 7·6.

I am, Sir, yours obediently,
H. ROMBERG.

Mr J. G. Barclay's Observatory,
Leyton, March 21.

CORRESPONDENTS' QUERIES—ANSWERS.

J. W. will find "Eyes and no Eyes" in *Evenings at Home*, by Mrs Barbauld and Dr Aiken. It is also frequently inserted in school reading books, such as M'Culloch's.—T. W. B.

D. T. K. may get the Meridian Line—Imprimis *by Compass*, allowing 21° for existing westerly variation: secondly, if accurate local time can be obtained, *by the shadow of a plumb-line* at apparent noon: or finally, by the old method of *equal altitudes*—fixing a pin truly perpendicular in a board, and describing concentric circles with it as a centre. Let him level the board accurately, and (preferably about the end of June or December, when the Sun's declination alters very slowly,) mark where the shadow of the top of the pin falls on each circle, both before and after noon. Let him now bisect the arcs between each pair of points, and a line drawn through these bisections will, if the operation has been carefully performed, pass also through the pin, and be a diameter common to all the circles. This line is the *meridian*. Of course an Altazimuth instrument, by two equal altitudes of a star, would give the meridian at once, and with great accuracy, but this would not be an "inexpensive" mode of getting it.—W. N.

List of Subscribers.

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An excellent and complete **Equatoreal Refractor,** clear aperture of object-glass $8\frac{1}{4}$ inches, focal length, $109\frac{3}{4}$ inches ; driving clock perfectly regulated by a pendulum vibrating half seconds. Price moderate. [19]

Equatoreal Telescope, $5\frac{1}{2}$ ft. focus, $4\frac{1}{8}$ in. aperture, powers 60, 340, and 450, on extra stout mahogany tripod stand, steadying rods, levels, large finder, &c., complete. [18]

Achromatic Refractor, 5 ft. focal length, 4 in. aperture, by *T. Cooke & Sons,* Equatorially mounted, with driving clock, micrometer, and illuminating apparatus. Price moderate. [28]

Astronomical Refractor, focal length 4 feet, aperture $3\frac{3}{8}$ inches, complete, on a Portable Universal Equatoreal Stand. [3]

Achromatic Refractor, 44 in. focus, $3\frac{1}{2}$ in. aperture, on a Fraunhofer's Universal Equatoreal Stand. [7]

Achromatic Refractor, 4 ft. focal length, 3 in. aperture, on brass tripod stand, with achromatic finder, 3 celestial and 3 terrestrial eye-pieces, &c. [20]

Astronomical Refractor, $2\frac{3}{4}$ in. aperture, 46 in. focus ; with a Portable Equatoreal Stand, and a Mahogany Tripod for terrestrial purposes. [14]

Newtonian Reflector, 7 ft. focus, $7\frac{1}{2}$ in. aperture, eight eye-pieces, powers from 30 to 360, Equatoreally mounted. [11]

Transit Instrument, 5 ft. focus, $3\frac{3}{4}$ in. aperture, Ys fitted with agates, for mounting on stone piers. [29]

Equatoreal Mounting, (for Latitude 51 or 52), adapted for a telescope of 6 or 7 foot focus.—12 inch Circles, Driving apparatus, &c., all of the most approved construction. [5]

Improved **Varley Stand,** with rackwork movements, adapted for a telescope of 5 or 6 ft. focus : fixed upon a circular turn-table, so as to be easily pointed in any direction. [16]

Recreative Science : complete in numbers, half-price. [30]

FOR SALE, an ASTRONOMICAL REFRACTOR, $2\frac{3}{4}$in aperture, 46in. focus, with a portable EQUATOREAL STAND, 6in. circles divided on silver, reading by verniers to one second of time and fifteen seconds of arc. Also a mahogany tripod for terrestrial purposes. One day, and five astronomical eye-pieces, powers 20 to 180. The Object-glass is first rate for its size : the Equatoreal would carry a telescope up to five feet focus.—Price £22. [14] E

FOR SALE—an excellent REFLECTING TELESCOPE, focal length 7 feet, aperture $7\frac{1}{2}$ inches, mounted so far Equatoreally that with a little care it may be turned on a star or planet in the day time.—Four Eye-pieces.—Price £20 only, (less than the cost of the stand,) the proprietor having mounted a larger instrument. [11] F

Monthly Notices of the Royal Astronomical Society.—The third Volume wanted : a good price will be given. [26]

NEBULOUS RING ROUND THE SUN.—On the 8th March, at Manchester, Mr Baxendell read an interesting paper on the *Periodic Changes in the Magnetic Condition of the Earth, and in the Distribution of Temperature on its Surface.* He considers that a ring of nebulous matter circulates round the Sun, upon which ring the forces which produce the solar spots alternately increase and diminish the attraction. The mean distance found for this ring is the same as that assigned by M. Leverrier to the ring of small bodies within the orbit of Mercury, which tends to confirm Mr Baxendell's theory.

TO CORRESPONDENTS.

N. B.—Articles received after the 20th of the month cannot be inserted, unless containing notices of fresh discoveries, or otherwise of immediate interest.

Communications from Readingensis—Juno—Hugh Elias—W. Wray—H—and some others, in our next.——Also as many letters as we have space for on the Moon Controversy, on which subject we have received a number of communications.——In addition, a Table of Recent Comets, by G. F. Chambers, Esq.

We have received the following communication from Dr Lee :—

Sir,—I shall be obliged to any member of the R.A.S. who may be in possession of the second volume of Schroeter's *Seleno Topographische Fragmento* if he will lend it to me during the approaching month of May. It is not in the library of the Royal Astronomical Society at Somerset House. And I shall be pleased to lend to any member of the Society any book in my library.

Hartwell, near Aylesbury, Sir, yours faithfully,
23d March, 1864. J. LEE.

ASTRONOMICAL REGISTER—*Subscriptions received for the year* 1864—the Editor's list.

To March.
Webb, Rev. T.W.
Wray, W.
Bass, J.H.

To June.
Lettsom, W.G.
Broughton, S.
Leigh, James

To September.
Barber, J.T.

To December.
Hubbersty, Rev. R.C.
Davis, H.
Dr Stodhart
Hall, Rev. J.R.
Simkiss, T.M.
Vernon, G.V.
Walker, G.J.
Baldelli, Mdme de

Those Gentlemen who have not yet sent their subscriptions for 1863 are particularly requested to do so.—The Subscription up to June 1864 is due.

CONTENTS.

The Astronomical Register.

No. 17. MAY. 1864.

MR. BIRT'S NEW CATALOGUE OF THE LUNAR CRATERS.

In the *Intellectual Observer* for April 1864 will be found an admirable paper (the first of a series) on the Moon, from the pen of the Rev. T. W. Webb. The main portion of the paper contains a very interesting description of the well-known spot the *Mare Crisium*, which should be in the hands of every student of the Moon's surface. In the introductory remarks, Mr. Webb refers to the "nomenclature" generally adopted by astronomers, and with reference to the smaller spots designated by Schröter and Beer, and Mädler, by Greek and Latin characters, he says: "A more comprehensive and universally available mode of designating every spot worthy of notice on the lunar disc is understood to be in the course of preparation by Mr. Birt, and will be a great acquisition to astronomers." As we are somewhat acquainted with the method Mr. Birt intends to adopt in drawing up a catalogue of objects on the Moon's surface that have been specially observed, and of which records exist, it may not be uninteresting to our readers if we give a short account of it, which we have received permission to do.

Mr. Birt divides the entire surface of the visible hemisphere of the Moon into zones of 5 degrees in breadth, subdividing them into spaces of 5° of latitude and longitude. He also takes larger areas of 25° of latitude and longitude, designating each larger area by a Roman capital, but each smaller one by a small Greek letter; thus the space in any quadrant from 0° to 25° of longitude and latitude is designated by the letter A, while the smaller space from 0° to 5° of latitude and longitude is distinguished by the symbol A^{α}, the next

space, 5° to 10° of longitude, A_{β}, and so on. To distinguish the features observed in these smaller spaces, an Arabic numeral is employed thus—$A_{\alpha 1}$ or $A_{\beta 3}$, and to indicate the quadrant in which the spot may be found, the ordinary Roman numerals I., II., III., and IV., are prefixed. We give one or two examples. The information that will be given in Mr. Birt's catalogue is, we understand, much more extensive than that given in the examples. Mr. Birt finds the method very available for recording newly observed features:—

I $A^{\alpha 1}$		Triesnecker, 14·03 Eng. miles diameter.
I $A^{\delta 6}$	2·51 N. Lat., 17·9 W. Long.,	Dionysius, 3,837 Eng. feet deep.
I $A^{\delta 10}$		Dionysius *a*, B. & M. 3,837 Eng. feet high.

ROYAL ASTRONOMICAL SOCIETY.

Sixth Meeting, 8th April, 1864.

Warren De la Rue, Esq., F.R.S., *President*, in the Chair.

Secretaries, Rev. C. Pritchard and Mr. Hodgson.

Thirty-one presents were announced, among them the usual serials.

C. Todd, Esq.,
H. S. Redpath, Esq., and
F. Bowman, Esq.,

were balloted for, and duly elected Fellows of the Society.

The new list of members, up to December 31, 1863, was announced to be completed, and would be forwarded to the Fellows.

On the Geocentric North Polar Distance of the Moon, and Moon Culminating Stars, by Sir Thomas Maclear.—This paper, Mr. Hodgson stated, tended to give a more accurate knowledge of the distance of the moon from the earth than had ever yet been attained to.

On the Minute Companions of Procyon and Sirius, by the Rev. W. R. Dawes.—On the 24th March, Mr. Dawes obtained views of the companion of Sirius, with his object glass by Alvan Clock, of 8¼ inches aperture. Although the night was not favourable, he obtained $P=84°$, $D=10''\pm$. On the 25th he had a better view, but clouds intervened before he could re-measure it.

On the Companion of Sirius, by Mr. Lassell. From a few measures recently obtained, the position varies from 78°·50 to 80°·15, and the distance from 10″·50 to 9″·71. Mr. Lassell used powers of 405 and 678; with the latter the small star could not be overlooked. It was

not a small point, although it varied in brilliancy; it resembled somewhat the 5th star in the trapezium of Orion. Mr. Lassell added that, although the late weather had been very unfavourable for observation, he had still been able to get some good views of the smaller stars in the trapezium.

On the Comparison of the Chinese Records of Solar Eclipses with the computations of Modern Theory, by the Astronomer Royal. Mr. Williams, the Assistant-Secretary of the Royal Astronomical Society, had given abstracts of the record of 36 eclipses from the Chinese annals, converting the dates to the Julian Calendar. Of these, 32 agree not only in day, but in general track of eclipse, with calculations of eclipses which must have happened, while two appear impossible, and much doubt is thrown on the other two.

The Rev. F. Howlett exhibited to the Meeting some pictures, showing the difference between the Ely and Kew photographs of the sun. There was a marked difference between pictures produced at the same minute at the two places. He instanced a group of spots on the 28th January, in which a large but feeble luminous bridge, occupying about one-fourth of the umbra, was given at Kew but not at Ely, although the subordinate spots were better rendered at Ely than at Kew.

Professor Selwyn attributed it to the small exposure at Ely, which fails in the faint parts, while it gives all the more salient features. He added that the artist at Ely had at length got the chemical focus of the instrument accurately, and would also be able to give the much-desired "lines of position."

The President explained that the object sought at Kew was not the depicting of physical features, but the position of spots; hence the plates were exposed for a longer time, which, although interfering with the delineation of the penumbra, brings out the minute specks of light much better—the Kew instrument also being in better chemical focus. It is possible to allow more attention to general features at Ely than at Kew. The President considered that the best plan was to get the picture on a considerable scale, with a large telescope such as he had employed, and either projecting the spot on a sensitive surface, or using an eye-piece to enlarge the focal image; this was better than subsequent magnification. Daily attention, and a man devoted entirely to the subject, were absolutely necessary, and any one carrying it out would reap a rich reward.

Mr. Pritchard read extracts from a letter from the Rev. W. R. Dawes, on *Nasmyth's Solar Willow-Leaves*. Mr. Dawes, having made fifty or one hundred times as many observations of the sun as most other observers, thought that at the age of 65 his eye was as good as any other that he knew of. It was on record that he could see the

companion to Polaris with 1·6 inches of aperture; but having been advised to *look again* for the willow-leaves, he did so, having first ascertained by looking again at Polaris that he could still see it with the above aperture. The observations of Mr. Stone and Mr. Dunkin have landed them just where he (Mr. Dawes) was 16 years ago. In 1848, with a new diagonal eye-piece, power 65, on a telescope of 6½ inches aperture (the whole aperture being used), he was struck with the appearance of bright particles scattered all over the sun, which he compared to excessively minute *fragments of porcelain*, not all the same size. Being an old bird, he was not to be caught with "rice grains!" He had seen too many optical illusions to trust to "new discoveries." It was four years before he was satisfied—not, in fact, until he had completed his new solar eye-piece, and was able to examine these particles with high powers, and was then convinced that these objects were but different conditions of the large luminous clouds themselves. He arrived at this about 12 years ago, and did not think further looking would alter his opinion, which he had come to, he might say, not from too little, but too much looking.

Mr. Pritchard suggested that looking through a very small hole might tend to obscure the real appearance of the sun, and asked whether the diffraction thus produced might not be the cause of some of the phenomena described by various observers. He also remarked that while Mr. Dawes compared his bright objects to "bits," the other gentlemen stated that these were "whole," or distinct things.

Mr. Huggins stated that he had observed the "rice particles" with his 8-inch object glass, and a power of 220, and found them not uniform in size, and on the average more round than oval. They were most distinctly seen on the darker parts, and in every case appeared separated with a dark portion between. They must not be confounded with Mr. Dawes' *straw thatching*, which appears on the edge of the spots, consisting of filaments, long but not pointed.

The Rev. F. Howlett had, on one occasion, distinctly seen the well-known mottling, appearing like crystalline flakes—not so close together as the willow-leaves or rice-grains.

Captain Noble had sought in vain for these appearances. On one occasion he thought he had got hold of the willow-leaves, and had he been Archimedes or a patent shirt-maker, he should have exclaimed "Eureka!" Still, however, he saw what Mr. Huggins had described—a series of dots, separated by dark intervals. Their circular character he could corroborate, but found no such thing as interlacing. The telescope he used was of $4\frac{2}{10}$ in. aperture.

Mr. Brayley stated that Mr. Nasmyth, in a letter he had received, described four different forms of willow-leaf—1st, the original form, the type of the penumbral strata; 2nd, a form shorter and wider,

found in the details of the bridges, &c.; 3rd, a still shorter form, found on the borders of bridges and margin of the photosphere; and 4thly, the rice-grain particles. The 3rd and 4th forms constitute the entire luminous photosphere.

Mr. Stone said that they were more like "rice" than any other name that had been applied to them, and that the higher the power he used, the better he could see them; and Mr. Lynn added that he had seen them, and that they resembled grains of corn, or a mass of bird seed, but not willow-leaves.

Mr. Hodgson said it was evident that all saw something, and possibly at different points of the focus. He had looked with Mr. Dawes through his telescope on a very fine day, and through one of his "little holes," and then did not see the willow-leaves; but he thought it greatly depended on the object-glass and the eye-piece. He must add that he did not think we possessed an astronomical observer whose eye was equal to that of Mr. Dawes when he was in good health.

Occultation of Stars by the Moon, observed by Captain Noble. A^2 Cancri disappeared instantaneously, March 18. ω Leonis on the 19th *nearly* instantaneously. Power used 150, adjusted on the star. Captain Noble stated that the duplicity of ω Leonis was indicated by its not disappearing instantaneously; but the twilight interfered with the observation.

Mr. Pritchard concluded the meeting by explaining a paper on *Shooting Stars*, by A. S. Herschel, Esq. More of these bodies are observed in autumn than in spring, and more at sunrise than sunset. They were considered to be planetoid bodies moving in space, and a theory to account for these two effects was brought forward, depending on the earth's motion in its orbit at the particular times mentioned. [Without the aid of diagrams, we fear we should not be able to give an intelligible account of this paper to our readers, and we, therefore, defer its consideration until a future opportunity.]

GAMMA ANDROMEDÆ.—Mr. Romberg has forwarded to us the following measures of this star, taken with Mr. Barclay's 10-inch refractor; power used 450, although Mr. Romberg states that the star is easily divided with 330.

			″		°	′		
1863.	Feb. 27.	d=	0·6 est	P=	107	47	5,65	12 meas.
	March 18.		0·6		105	43	5,65	6 „
	March 19.		0·6		107	10	5,65	4 „
	Dec. 14.				108	44		9 „
	Dec. 18.		0·586 meas.		107	7	5, 7	8 „
1864.	Jan. 8.		0·637		107	18		7 „

ASTRONOMICAL OCCURRENCES FOR MAY 1864.

DATE.		Principal Occurrences.		Jupiter's Satellites.		Meridian Passage.
		h. m.			h. m. s.	h. m. Saturn. —
Sun	1	 1 30	Sidereal Time at Mean Noon, 2 38 39·9 Conjunction of Moon and Mars, 6° 53′ S.	1st Sh. I. „ Tr. I. „ Sh. E. „ Tr. E.	8 56 9 13 11 8 11 24	 10 10·8
Mon	2			1st Oc. R.	8 43	10 6·6
Tues	3			2nd Ec. D. „ Oc. R.	13 9 21 15 51	10 2·5
Wed	4	1 24	Conjunction of Moon and Venus, 3° 51′ S.	3rd Sh. I. „ Tr. I. „ Sh. E. „ Tr. E.	9 31 10 32 11 40 12 15	9 58·3
Thur	5	12 14	Eclipse of the Sun—invisible at Greenwich ● New Moon	2nd Sh. I. „ Tr. I. „ Sh. E. „ Tr. E.	8 15 8 39 10 35 10 54	9 54·2
Fri	6	22 54	Conjunction of Moon and Mercury, 3° 49′ N.	1st Sh. I.	16 21	9 50·0
Sat	7			1st Ec. D. „ Oc. R.	13 44 9 16 1	9 45·9
Sun	8	7 51	Conjunction of Moon and Uranus, 3° 9′ N.	1st Sh. I. „ Tr. I. „ Sh. E. „ Tr. E.	10 50 10 57 13 2 13 7	9 41·7
Mon	9	11 43	Conjunction of Mars and φ Aquarii, 6m·4 W.	1st Ec. D. „ Oc. R.	8 12 41 10 27	9 37·6
						Moon. —
Tues	10			2nd Ec. D.	15 44 16	3 51·9
Wed	11		[It will be seen that the 3d Satellite *passes* its shadow on the disc of Jupiter during transit]	3rd Sh. I. „ Tr. I. „ Tr. E. „ Sh. E.	13 30 13 48 15 33 15 38	4 39·2
Thur	12	18 46	Opposition of Jupiter [Second Satellite — see note above.]	2nd Sh. I. „ Tr. I. „ Tr. E. „ Sh. E.	10 50 10 53 13 9 13 11	5 24·3
Fri	13	6 21	☽ Moon's First Quarter			6 7·7
Sat	14			1st Oc. D.	15 34	6 50·1
Sun	15			1st Tr. I. „ Sh. I. „ Tr. E. „ Sh. E.	12 40 12 44 14 51 14 56	7 32·2

DATE.		Principal Occurrences.		Jupiter's Satellites.		Meridian Passage.
		h. m.			h. m. s.	h. m. Moon
Mon	16		Sidereal Time at Mean Noon, 3 37 48·2	1st Oc. D. / " Ec. R.	10 0 / 12 14 15	— / 8 14·9
Tues	17	11 51	Conjunction of Moon and Saturn, 6° 8′ N.	1st Tr. E. / " Sh. E.	9 17 / 9 25	8 59·0
Wed	18	6 43	Near approach of Moon to B.A.C. 4531 (6)			9 45·3
Thur	19			2nd Tr. I. / " Sh. I. / " Tr. E. / " Sh. E.	13 17 / 13 25 / 15 23 / 15 46	10 34·5
Fri	20	9 54	Conjunction of Moon and Jupiter, 0° 52′ N.			11 26·7
Sat	21	1 24	○ Full Moon	2nd Ec. R.	9 52 29	12 22
						Saturn.
Sun	22	9 32 / 10 32 / 22 0	Occultation of B.A.C. 5866 (6) / Reappearance of ditto / Inferior Conjunction of Mercury	3rd Ec. R. / 1st Tr. I. / " Sh. I.	9 36 48 / 14 24 / 14 38	— / 8 44·3
Mon	23	10 45	Occultation reappearance of 21 Sagittarii (5)	1st Oc. D. / " Ec. R.	11 44 / 14 8 25	8 40·2
Tues	24	11 16 / 12 13	Occultation of B.A.C. 6658 (6) / Reappearance of ditto	1st Tr. I. / " Sh. I. / " Tr. E. / " Sh. E.	8 50 / 9 7 / 11 2 / 11 19	8 36·2
Wed	25			1st Ec. R.	8 36 56	8 32·1
Thur	26			2nd Tr. I.	15 22	8 28·1
Fri	27	21 21	☾ Moon's Last Quarter			8 24·0
Sat	28			2nd Oc. D. / " Ec. R.	9 27 / 12 28 13	8 20·0
Sun	29	19 12	Conjunction of Moon and Mars, 5° 58′ S.	3rd Oc. D. / " Ec. R.	10 6 / 13 35 29	8 16·0
Mon	30			1st Oc. D.	13 28	8 12·0
Tues	31			1st Tr. I. / " Sh. I. / " Tr. E. / " Sh. E	10 35 / 11 1 / 12 46 / 13 13	8 7·9

THE PLANETS FOR MAY.

Mercury may be seen in the evenings at the beginning of May, setting about half-past nine on the 1st. It is situated in the constellation Taurus.

1st.	R.A. 3 57 20	Decl. N. 23 11	Diameter	8″·8
31st.	„ 3 48 43	„ 16 28½	„	11″·8

Venus is now too near the sun to be well observed. It passes from Pisces into Taurus, rising about five o'clock in the morning on the 1st and about twenty minutes past three on the last day of May.

1st.	R.A. 1 17 57	Decl. N. 6 33	Diameter	10″·4
31st.	„ 3 40 16	„ 18 40½	„	9″·8

Illuminated portion of the disc of Venus—0·955.

Mars rises about three o'clock in the morning at the beginning, and about half-past one at the end of May, passing from Aquarius into Pisces.

1st.	R.A. 22 49 47	Decl. S. 9 9½		
31st.	„ 0 12 42	„ 0 36½	Diameter	6″·4

Illuminated portion of the disc of Mars—0·878.

Jupiter arrives at opposition on the 13th of the month, and is then at its greatest brightness for the year, but its low altitude interferes with the definition necessary for good observations of so bright a body. It continues in the constellation Libra, rising about a quarter past eight in the evening at the beginning and about six o'clock at the end of May.

1st.	R.A. 15 28 32	Decl. S. 17 41½	Diameter	42″·0
31st.	„ 15 13 27	„ 16 48	„	41″·8

Saturn is well visible in the constellation Virgo during the evenings in May, setting about four in the morning at the beginning and two o'clock at the end of the month.

1st.	R.A. 12 51 13	Decl. S. 2 32	Diameter	17″·2
31st.	„ 12 46 15	„ 2 7	„	16″·6

Dimensions of Ring—Outer major axis, 42″·0. Outer minor axis, 6″·4.

Uranus is now getting unfavourably placed for observation.

4th.	R.A. 5 28 55	Decl. N. 23 24½
28th.	„ 5 34 34	„ 23 28½

THE MINOR PLANETS.

The following are the Minor Planets which will be on, or within one hour of Right Ascension on either side of, the Meridian, between nine and twelve o'clock during the evenings of May. Their places are to be found in the supplement to the *Nautical Almanac* for 1867.

	Magnitude.		Magnitude.
Juno...	9·9	Circe	11·5
Thetis	9·3	Hestia	12·5
Calliope	10·5	Virginia	13·4
Phocea	10·5	Europa	10·6
Bellona	10·6	Danae	12·2
Urania	10·7	Erato	12·6

TABLE OF NEBULÆ.

Right Ascension Eleven Hours.

NAME OF NEBULA.	Right Ascension.	Declination.
46 Hersch. v. Ursæ Majoris	11 3 30	+56 23½
A very elongated object, without any sign of condensation. There is a minute star upon the nebula.		
97 M. Ursæ Majoris	11 6 55	+55 45
A large, ill-defined, somewhat faint planetary nebula.		
50 Hersch. ii. Leonis	11 9 45	+18 47
Relatively faint, but showing signs of condensation. A smaller nebula, 51 Hersch., to the N. of it, is fainter still.		
66 M. Leonis	11 13 5	+13 44
A very fine nebula, or rather pair of nebulæ, as two are in the field together with the power employed; both brighten towards their centres, notably the following one.		
219 Hersch. i. Ursæ Majoris	11 17 15	+39 30
Of some size, but pale and faint.		
194 Hersch. i. Ursæ Majoris	11 18 45	+44 19½
Rather elongated and tolerably bright, condensing towards the centre.		
94 Hersch. i. Ursæ Majoris	11 34 10	+37 17½
Faint, pale, and indifferently defined.		
173 Hersch. i. Ursæ Majoris	11 45 55	+37 44½
Well seen, though not large; an apparent stellar nucleus is very evident to an averted eye.		
45 Hersch. i. Ursæ Majoris	11 46 45	+53 5½
Very faint and pale.		
62 Hersch. iv. Ursæ Majoris	11 48 25	+55 51½
A planetary nebula; a dim object.		

The nebulæ in the 11th Hour of Right Ascension are more numerous than important. Several of the objects, however, in our list will repay the observer for careful scrutiny of them. Among these, our 4th nebula, 66 M. Leonis will be found of considerable interest; it is preceded in the same field by 65 M.; both show palpable signs of condensation; while in the case of 66 M. that peculiar glow or glitter which indicates resolvability will be seen by a little attention. 46 Hersch. V. Ursæ Majoris is chiefly noticeable from the fact, that a very minute star, evidently utterly disconnected with the nebula, is projected upon it. 173 Hersch. I. Ursæ Majoris has an apparent stellar nucleus, which is very evident to an averted eye. This object has been described as resembling "a star in a brier," and the comparison is really an apt one. None of our remaining objects call for any special remark.

CORRESPONDENTS' QUERIES.

What is the magnitude of the little star S.P., the fine double star 170 P. VII. Canis Minoris? Smyth in his cycle gives it as of the 11th magnitude, but it appears to me quite as bright as the 9½. May it not be variable? H. I.

Can you inform us whether a comet should be named after the date of its discovery, or of its perihelion passage? There appears to be some little confusion with regard to the comets V. and VI., 1863, owing to their having been named on both principles. E.

We find in the *Reader* of April 23rd a tolerably full report of the Meeting of the Royal Astronomical Society on the 8th of that month. This is a step in the right direction, and the public will be glad to know a little more of what passes at the meetings. It is desirable, however, that these reports should be read over by some one conversant with the subject; with the greatest care, errors will creep in, but the phrase "Comparison of Sirius," instead of "Companion," occurs twice.

Aurora Borealis.—Mr. R. H. Allnatt, of Frant, writes to the *Times* to state, that a splendid display of this phenomenon was observed on the evening of the 18th of April, about half-past 10 o'clock, lasting about an hour.

Observatory for Dundee.—Mr. D. M. Webster, of Dundee, in a letter dated April 8th, writes—"You will be glad to hear that I am endeavouring to get a Public Observatory erected here, in which a powerful equatoreal is intended to be placed. Several gentlemen have taken up the matter, and I have no doubt that it will soon be carried forward."

Mercury and Saturn.—"Looking at Mercury on Tuesday last, I fancied that, at moments of the best vision, I could see his southern horn somewhat blunted. The impression recurred so many times that I almost satisfied myself that this blunting had an objective existence. Saturn is unfortunately low down, but I have once or twice seen a good deal of detail upon him; the great division between the rings A and B is visible enough now; the north polar capping seems homogeneous, and of a pale Indian ink colour, affording a most marked and curious contrast to the appearance of the south pole of the planet, which during the years 1859–60 used to be covered with *rust-coloured belts*. The nebulous ring C is also beginning to show well in the ansæ."—*Extract of Letter from Captain Noble, April* 25, 1864.

CORRESPONDENCE.

N.B.—We do not hold ourselves answerable for any opinions expressed by our correspondents.

CLOSE DOUBLE STAR NEAR "CASTOR."

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—The 7th magnitude star 1° 15′ south following Castor, I perceived last night, with my 12-inch silvered speculum, to be a close pair consisting of two 8th magnitude stars of a fine golden yellow colour, and separated by an interval much less than 1″. On referring to my friend, Mr. George Hunt, of Edgbaston, who is rich in maps and catalogues, he tells me that the star, although without a number on the society's maps, is No. 2489 of the B.A.C., and that no mention is made of it in the Dorpat catalogue.

The Rev. W. R. Dawes and Mr. Romberg very kindly examined and reported upon the small star near Procyon, a notice of which star I sent you some time ago; perhaps they would do the same in reference to the star near Castor, and state whether it be amongst the few double stars which have hitherto escaped observation.

I am, Sir, yours faithfully,
F. BIRD.

Key Hill, Birmingham:
April 21st, 1864.

"TELESCOPES WITHOUT TUBES."

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—The telescope referred to by Mr. J. M. Stothard in the April number of the *Register*, is an unsilvered glass Newtonian reflector, of 12 inches diameter, 10 feet 6 inches focus. This instrument I have lately completed for the special purpose of observing the details of the sun's surface.

So far as the optical arrangements of this telescope are concerned, it is constructed in general accordance with the suggestions originally given by Sir John Herschel in his "Cape Observations." The only novelty (if I may so term it) that I have introduced, is that of dispensing with the tube usually employed in reflecting telescopes.

My reason for dispensing with the tube of this telescope is, in order to get quit of those whirling currents of air which, in sun observations especially, become a source of serious damage to the definition. The sun shining right down through the column of air contained by the tube, occasions whirling currents and mixtures of air of different temperatures, through which the rays that have to form the image have to traverse twice, and in doing so, get so interfered with as to result in defective definition. By dispensing with the tube, this source of evil is at once done away with.

In order to support the small diagonal plane mirror and eye-piece, and

retain these parts in perfect relative position with respect to the great mirror, I employ a rigid rod fastened to the side of the cell of the mirror. This answers its purpose perfectly; and as the cell of the mirror is mounted on a swivel joint, and that again on a free-moving turn-table resting on the ground, I have the utmost ease of motion in every direction, accompanied by great steadiness. While observing, the eye-piece end of the side rod rests on an ∧ support, which in "a practised hand" answers every purpose: nothing can exceed the simplicity and general efficacy of the whole affair.

I am yours very faithfully,
JAMES NASMYTH.

Penshurst, Kent:
April 12th, 1864.

JUPITER'S SECOND SATELLITE.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—If you will allow me space in your interesting journal, I wish to call attention to a curious oversight committed by many of our most eminent writers on Elementary Astronomy, in reference to the eclipses of Jupiter's second satellite. It is asserted by these authors, that "in any single eclipse" of this satellite, "*both* the immersion and emersion can never be observed." Now, in the explanations of the articles in the *Nautical Almanac*, at the end of the volume, it is stated (page 536 of the present year)—"It is seldom, also, that the disappearance and re-appearance of the second satellite can be observed at the same eclipse; but both phenomena are generally visible with the third and fourth satellites." Any one who will consult the volumes of the *Nautical Almanac*, will find that *it is seldom* that both the immersion and emersion of this satellite can be observed in the same eclipse; nevertheless, there are instances, and notably in this year, on February 29th and July 31st, besides several other instances not visible at Greenwich. In the former of these, February 29th, the satellite emerges from the shadow and is visible before being occulted, nearly 9 minutes; in the latter, July 31st, the satellite will re-appear, having been occulted by the planet, and will be visible more than 16 minutes before entering the shadow and being eclipsed. The night, or rather morning, of February 29th being hopelessly cloudy, I was prevented from observing the phenomenon for myself, but I hope to be more fortunate on July 31st. The authors in whose works I have noticed this oversight (with great deference be it spoken) are, Brinkley (Elements of Plane Astronomy, edited by Luby), Woodhouse, Maddy, Sir J. Herschel (Outlines of Astronomy), Mrs. Somerville (Connexion of Physical Sciences), Malkin (Astronomy in Library of Useful Knowledge), and, very curiously, the superintendent of the *Nautical Almanac*, Mr. Hind (Introduction to Astronomy, 3rd edition, p. 100). The authors whom I have consulted, whose statements in reference to the second satellite agree with that in the *Nautical Almanac*, are, Vince (Principles of Astronomy), Inman (Navigation and Nautical Astronomy), Smyth (Celestial Cycle), Webb (Celestial Objects for Common Telescopes), and the Penny Cyclopædia, article "Jupiter."

Yours obediently,
G. H.

Birmingham:
April 9th, 1864.

A BRILLIANT METEOR.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—On Wednesday evening, March 23rd, about 7h. 30m. M.T., I happened to be looking at the moon, when my attention was arrested by the sudden appearance to the left of a large and beautiful meteor, which slowly descended in a direction nearly perpendicular, but slightly inclined to the south. It was pear-shaped, was extremely brilliant, in colour blue, with a mixture of purple, and left a train fully 20° in length; the upper portion of which had disappeared at the time the nucleus exploded, which it did when about 23° from the horizon. The strong moonlight prevented my being able to take its real position, but as nearly as I could judge, its first appearance was a little to the right of the cluster of stars in Coma Berenicis, and in its downward course (which occupied from 4 to 5 seconds), it left Beta Leonis a little to the right. I send this in the hope that it may elicit notices (of its real position, &c.) from others who may have seen it.

I am, Sir,
Your obedient Servant,
West Bromwich: March 28, 1864. SAMUEL ADAMS.

A GREAT COMET PREDICTED.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

[*Liverpool Mercury*: March 18th, 1864.]

The following is an extract of a letter just received from Melbourne:—"Professor Newmager, on a three years' scientific visit from Bavaria, tells us that in 1865 a comet shall come so close as to endanger this our earth; and should it not attach itself to us (as one globule of quicksilver to another), nor annihilate us, the sight will be most beautiful to behold. During three nights we shall have no darkness, but be bathed in the brilliant light of the blazing train!" The professor was leaving Australia for Bavaria, so that we may hear more of this on his reaching Europe.

Sir,—The above appeared in the *Liverpool Mercury* of the 18th inst. As an amateur astronomer, I am anxious to know if there is any truth in it, and if so, whether the above comet will prove to be one of the small periodical members of the solar system, calculated to cross the earth's orbit in our then immediate neighbourhood, or some gigantic stranger returning from a 200 years' excursion in space, with illuminating powers sufficient to dispel the midnight gloom for three consecutive nights, and if there is any danger likely to result from the drop of mercury hypothesis, and the chances of this world being knocked into a hundred asteroids, or a shower of meteoric stones to puzzle the inhabitants of Venus. Doubtless if laid before your numerous readers, some amateur of the advanced class will be found to sift the above predictions pro and con., and enlighten—

Yours very truly,
Liverpool: March 21, 1864. HUGH ELIAS.

THE PLANET VULCAN.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—I suppose M. Le Verrier knows something of what your mundane "literature" says as to my *Vulcan's* supposed re-appearance among the celestials. Why, then, does *he* prefer to imagine the existence of an *unseen* "ring of asteroids between the Sun and Mercury, the aggregate mass of which is comparable to that of Mercury," rather than believe in the existence of that "*one something*," which (Mr. Chambers reminds me) M. Lescarbault thought he saw (five years ago this month), and took for my long-lost dear Hephæstus? It was because Mr. Chambers so evidently *believes* what M. Le Verrier *does not believe*, that I spoke through you, partly compassionating you poor mortals' strange credulity, and partly in the vain hope that the earth-born intellect might have helped an agonised celestial mother to find her child where she has sought for him in vain.

Mr. Chambers is of opinion—at least he "believes"—that the same disturbances would be produced upon the swift path of *Mercury*, either by a ring of asteroids dispersed all round about the sun, or by their aggregate mass and attractions being concentrated in *Vulcan*, or in two or three other "good-sized" bodies! Well, Sir, this is not the first time that Vulcan has been a match for all the gravity of heaven! Olympus now rings again with laughter at this fresh mortal utterance; so that I can scarcely find breath gravely to ask M. Le Verrier to compute how long even a ring of asteroids would last, in the neighbourhood of the burning *Sol*, by whom they are ever being voraciously consumed, as you mortals have recently found out. M. Le Verrier may not like this question coming to him through an English medium; but, if not, you have Mr. Adams at Cambridge, one other of the modern giants, who have successfully scaled the highest heavens!

Haply the D. oracle will reveal, by Jupiter! that the "black spots traversing the sun's disc," of which Mr. Chambers speaks, are but the shades of the departed, led by Mercury to the dark regions of Pluto, now known to exist, by being *seen*, within Sol's dazzling photosphere of "willow-leaves!" What secrets can the gods hope to preserve, when everything you men believe is brought to the "test of observation?"

JUNO.

Mt. Olympus: the Ides of March, 1864.

DARKNESS AND LIGHT.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—I feel much obliged to both your correspondents for their replies to my queries respecting light: but if I express my further difficulties in the matter they will not, I trust, attribute them to any predetermined resolution to cling to *mistaken* views. It appears, then, first, that my ground upon which I based my difficulties was altogether wrong; the celestial orbs do *not* revolve around "their primary in *a sea of light*." Am I to understand that their movements are carried on through a region of *dark-*

ness? I cannot realise the idea of the *invisibility of light.* We have the calculated time to a fraction of a minute which a *beam of light* occupies in moving from the sun to the earth. It is not an instantaneous effect, but one of *progress.* The progress of what? Is it light or is it darkness? Supposing Mr. Glaisher were to mount in his balloon beyond the regions of our atmosphere, and could exist under the circumstances, how would the sun appear to him? Would that orb be divested of all its glory, and seem to the eye unprotected as it does through the darkened telescope—a round ruddy body without emanations? These are the points upon which I am perplexed. One word as to my last sentence in my last letter, which certainly is obscure, and requires some amount of "light." What I meant to say was this: that, if the original idea of the sun revolving round the earth had been correct, the light *would* have preceded, accompanied, and gradually have followed that body, as we witness every morning and evening.

Apologising for trespass upon space, Mr. Editor,

I remain yours,

March 22, 1864. READINGENSIS.

P.S.—Since I sent you the above, the April number of the *Register* has appeared, containing a letter signed "Ruricola," scattering his contempt for other writers more lavishly than politely. He forgets that scientific facts or theories may be viewed otherwise than through the medium of *his* spectacles, and seems to say that when he, "Sir Oracle, does ope his mouth," no small canine must dare to bark. But with respect to *my* "mare's nest." He tells me that if I were shut up in a dark room and the rays of the sun admitted through a small hole, that I should see no *light* at all, only the *illuminated* particles of dust. What do you *mean*, my good friend Ruricola? Shall I see *nothing* but the particles of dust? If so, the more dust we kick up in a dark old lumber-room the *better* we shall *see* what we are about. *But* if I see *something* besides *dust*, you admit the hollowness of your argument. This something *must be light, visible light* too, must it not? What do *you* call it, esteemed luminary? If I have found a mare's nest, it contains at least one "nest egg," the contents of which you may possibly extract, even without the aid of "Grandmama," before the June number of the *Astronomical Register*.

Reading: April 6, 1864. R.

A TEST FOR "RURICOLA."

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—The pages of the *Astronomical Register* are too valuable to be filled with "chaff" unredeemed by a grain of wit. A man can better employ his tongue or pen than in bandying impudence with *Ruricolas*; but still it is sometimes a duty even to "answer a fool *according to his folly*, lest he be wise in his own conceit;" and I therefore beg your leave to tell "Ruricola" that I cannot value his instruction even at the low price of twopence he himself has put upon it. "According to" his vulgar style, I might add, that his cephalic development had need to be large, to match the extensive aural organs he exhibits.

But there is another precept I am still more anxious to observe—"Answer *not* a fool *according to his folly*, lest you be like unto him." A "mare's nest" has certainly been discovered *either* by me *or* by "Ruricola." The person who arrogates a tone like his ought surely to live in or very near *town*, and to be a "professor" at the least, or perhaps a "scientific critic." If he is not afraid, then, to be proved the stolid occupier of "the equine nidification," he says, he has "encountered," let him give his name; and I shall throw such a beam of light upon those small particles of *pseudo*-science he has paraded anonymously as will give him an unenviable reputation for the rest of his life. If I fail, let the disgrace be mine—you, and your readers, and the public being judges. This test will not cost him a penny, but it will try his courage and honesty.

Yours faithfully,

J. REDDIE.

Hammersmith: 4th April, 1864.

P.S. However I may differ from "Readingensis" and "Enquirer," or they from me, we at least all agree in this, that our letters have been urbane and gentlemanly, and not like *Ruricola's*, which is unworthy of the matters discussed, and in marked contrast with those of all your other correspondents on the same subject.

THE MOON CONTROVERSY.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—Your correspondent "Ruricola" seems to have been so put out by my mode of determining the Moon's *non*-rotation, as to have lost both his temper and his reasoning powers, and is more qualified, by his reply to my query, for a lunatic asylum than my lunarian. Pray, where did he find out that the earth and the moon were travelling together like two parallel trains? Does he adopt Mr. Reddie's theory, that the moon, like the earth, travels in a circle round the sun? His illustration has no bearing on the case. I asked a simple question:—If the moon rotates on its axis, how is it that a lunarian would see the earth, at a distance of 237,000 miles, always in the same position? If Astronomers are right, there must be a convincing answer to this; but Ruricola's letter proves that he is not able to give it. And as he asks, How it is, if the moon does *not* rotate, that the face of the heavens does not appear stationary to her? I answer him most easily: There happens to be such a thing as *revolution* as well as rotation; and, by her revolution in her orbit round the earth, the moon turns round, and so presents every part of her surface to all points except the earth. But this is totally distinct from rotation on an axis.

I am, Sir, yours obediently,

AN ENQUIRER.

Cambridge: April 4, 1864.

P.S. Arago says (vol. ii. p. 254, English translation), "Simplicius asserts positively that the moon always presents the same face to us, and hence

he infers that she has no rotatory movement. This conclusion, inadmissible on every account, arose from the circumstance of Simplicius and his contemporary astronomers supposing that the moon is borne along through space by the crystalline sphere to which they conceived her to be attached. It was certain that, relatively to the material parts of this pretended sphere, the moon did not rotate, but her movements of rotation in space were evident, since an observer, placed outside the curve described by her, would see, necessarily, every part of her surface." M. Arago commits the error, so common among astronomical writers, of confusing rotation with revolution; but I would ask those who agree with the above quotation this simple question:—Can any alteration in the circumstances or forces acting on a moving body be said to have altered its movements, when its movements continue to be *precisely* what they were before such alteration in the forces? Even Ruricola will scarcely say it can. And if the moon did *not* rotate, when it was supposed to be attached to a sphere, why is it said to rotate now that it is supposed not to be so attached?

Admiral Smyth (Cycle, vol. i. p. 121), after quoting the usual astronomical formulæ on the subject, adds: "The question is intricate, since the lunar system displays a very singular coincidence of effects, totally independent of each other." It would be well if others of our astronomical writers had imitated the modesty of the gallant Admiral, when treating of subjects on which more than one opinion has been expressed.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—The absurb moon controversy will never be settled until both sides start from a definition of rotation in which they agree.

Since rotation signifies turning round like a wheel, let a plumb-line of sufficient length be suspended from the axle of a carriage-wheel just behind the nave. Lift the axle with a jack and turn the wheel round. What follows? Why, that every point of its circumference moves in succession past the plumb-line. Hence a *general* definition. A body rotates about its axis when every point of its surface passes in succession through any one of its meridian-planes *fixed in direction*. A plane fixed in direction is, of course, one which remains *parallel* to *itself*, whatever motion of *translation* it may have in space.

Apply this to the case in dispute. Suppose a plane fixed in direction, drawn through the moon's axis. Every point of her surface passes through this plane in the course of one revolution round the earth: therefore she rotates on her axis once in the same time.

For the purposes of the argument, the terminator may be considered (during a given short time) to lie in a lunar meridian-plane fixed in direction. We *actually see* the successive points of the moon's surface passing through the terminator every month—*emerging* from new moon to full, *immerging* from full to new.

Gainsayers of the lunar rotation must address themselves to upsetting the definition; the facts are immovable.

The fallacy by which so many of your correspondents are misled evidently lies in their referring the moon's rotation to the *centre of her*

orbit, instead of to that which is the only true criterion, viz. *a plane fixed in direction drawn through her axis.*

I am, Sir, your obedient Servant,

Cartmel: April 11, 1864. R. C. HUBBERSTY.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—One of the most extraordinary and amusing things about the moon controversy is, that the illustration which is relied upon by the supporters of the moon's rotation as best calculated to carry conviction to the minds of those who advocate it, is in fact one of the most convincing which can be adduced on the other side of the question.

Mr. Dawes says that "*rotation signifies turning like a wheel.*" Then the moon does not turn like a wheel, but turns like a body carried round on the *rim* of a wheel; hence it only *revolves* round a distant centre.

A patent agent remarked the other day that "Were their ideas of rota-" tion and revolution so vague as they appeared to be amongst astronomers, " many a patentee would lose his right by infringement."

Amongst engineers—

Rectilinear motion means a progressive motion in a straight line;
Revolving motion, a progressive motion in a circle; and
Rotating motion, a twisting motion, or turning round like a top, on a centre *within* the body.

In the favourite illustration of a line of soldiers about to "wheel" round the "pivot-man," the latter twists as it were, or, in other words, one half of his body moves *forward* with the other men whilst his other half moves *backwards*. All the men in the line but himself move *forward bodily in circular paths*, and consequently revolve round the rotating "pivot-man."

I beg to apologise for offering you such simple elementary explanations, which, however, seem to be rendered necessary by the strange and most unaccountable misapprehensions in the simplest dynamical subjects, so well understood in factories and by mechanical engineers.

I remain yours respectfully,

London: April 11, 1864. AN ENGINEER.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—After the admirable and lucid exposition of the moon's axial rotation by the Rev. W. R. Dawes, it would seem almost a work of supererogation to add anything further upon the subject. Yet, inasmuch as your correspondents Cyclops and S. B. K. seem utterly to misapprehend the object of attaching the string to the fender in my suggested experiment, and your correspondent J. R. appears to be in a hopeless muddle with reference not only to co-existing motions, but also with regard to relative and absolute motion altogether, I may perhaps crave a few lines for a reply.

In the first place, then, I suggested that the string should be attached to the fender in order to afford an *external* point of reference, by which alone we can test the fact of rotation. To attach it to the lamp or table, as proposed, would be simply absurd. The sole effect, then, would be to exhibit proof of revolution round the centre, which we do not require, as nobody (save J. R.) denies it. The mere fact of the experimenter moving round the table during the same time that it occupies him to rotate upon his axis, would, if the centre of the table were the point of attachment of the string, *unwind* it at precisely the same rate as his axial rotation could wind it round him, so that the only practical effect would be to keep it stretched; and these considerations will show the fallacy underlying Cyclops' second case also. Before passing to your other correspondent, I may perhaps be allowed to ask Cyclops two questions—1st, Do or do not the fixed stars appear to rise and set to the moon, and if so, how can these appearances conceivably be presented to her, unless she rotates upon her axis? and 2ndly, How does Cyclops explain the phenomenon of lunar libration in longitude, if it be not that the moon's axial rotation does *not* (most fortunately for illustration) correspond accurately with that of her revolution round the earth?

But "Finis coronat opus," and in J. R.'s communication we find so helpless a confusion of relative and absolute motion as to render it difficult to deal with so perfect a scientific Ishmael. "The moon's real path" (says this most astonishing philosopher) "is not a circle or ellipse *round the earth* (?), but only a wave line. . . . . A simple open arch!!!!!" An open arch with reference to *what*—the sun or the fixed stars? If our satellite does *not* revolve round the earth in a month, will your correspondent be so kind as to explain her phases as viewed from it?

As one of the "illuminati so potent in repetition of all we have heard since we were babies" (and I am tempted to think that all J. R.'s existing knowledge must date from that period), I should like to ask what the path of a ball would be if spun in a roulette table in a railway carriage in motion. With reference to a fixed object like a telegraph post, it would doubtless be epicycloidal, but I scarcely fancy that any one (whose education had not been completed in his infancy) would deny that it described a circle in its box.

I am, Sir, Your obedient Servant,

OCULI AMBO.

7th March, 1864.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—I beg to submit the following remarks in the hope of simplifying, if not settling, the question of the moon's *rotation*, believing its difficulty to arise principally from an ambiguity in the term, conveying different ideas to the minds of the disputants.

Following the *verbal* etymology, we have this motion simply exemplified in the turning of clock-wheels, grindstones, millstones, &c., on *their own* axes, locally fixed. If to such *rotatory* motion, as in a carriage-wheel, a *progressive* one be added, we shall then have a *two-fold* motion, one of *revolution*, and the other of *rotation*, round a progressing axis, identical with the movements of the earth and other planets.

If, however, a drag be now attached to the wheel, virtually uniting it to its axis by a sort of physical connexion, the *rotatory* motion will at once cease, leaving merely one of *revolution*, according to the recognised use of the term in Dynamics, or what Aristotle speaks of as possible, viz. "a single continuous circular motion."

Now, it is this *drag* motion, thus deprived of rotation, which illustrates that of the moon, both bodies uniformly presenting *one* and *the same* projection towards the middle of the earth, as the common centre of their orbits, but continually *shifting* ones—towards the several points of the compass. Could the earth be similarly dragged, its motion would obviously become one of simple *revolution*, like that of the moon.

This kind of motion is also illustrated by the apple *tightly* nailed to a revolving cart-rim, as supposed by "Another Enquirer" in your March number. But the case of the *loaded* apple *freely* suspended on the nail, which in fact revolves *within* it, like the pivot of the magnetic needle also on a revolving wheel, exhibits a *compound* motion, not analogous to, but exactly the reverse of, the moon's motion as above described, i.e. they both, by virtue of the so-called law of gravity, and the magnetic polar attraction acting on them respectively, present ever *shifting* points towards the central nave, but *one* and *the same* point towards the surrounding space.

I submit these considerations in no spirit of bigotry or dogmatism, but am quite open to conviction by any more conclusive arguments than my own which might be adduced on the other side of the question. At present, however, I see no means of verifying the theory of the moon's *rotation* in the *strict* and *ordinary* sense of the term, but to deny the possibility of the "continuous circular motion" alluded to above, being also a *single* one, and by *loosely* including in this motion the *double* idea of *revolution* and *rotation*. The philosophical accuracy of this view I would not undertake to determine.

Beyond the arguments already brought forward, I fear there is no prospect of settling this now "Vexata Quæstio," but by a majority of votes at a *public meeting*, or by referring it to the Commissioners "De *lunaticis* inquirendos," which may be Englished by "enquiring into matters pertaining to the moon."

I remain, Sir,
Yours very faithfully,
M. A.

April 14, 1864.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—I think there is much in what one of your correspondents says about the *whole face of the heavens* being changed to the moon. Another reason why I think with him is, that one side of the moon must necessarily describe a larger circle round the earth than the other, therefore the side nearest to us must travel over a smaller space than that which is hidden from us. Now if the moon were travelling in a straight line, and one side travelled faster than the other, it would rotate. The matter can be argued from both sides of the question, but I must say there appears to be an axial rotation.

I am, Sir, truly yours,
J. G.

Yarmouth: April 2, 1864.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,— When a ship sails round the world, what does it do *besides* sailing round, or "revolving"? It always keeps its bottom to the centre, as the moon does towards the earth; and the ship simply *can't*, also, "turn on its axis."

Or, to take Mr. Dawes' illustration, if the Pivot-man holds a pole in his hand with a bayonet at the end; and were he—it is a cruel but telling way of proving the point— to stick that bayonet through the outside man, and then they turned round together; it is surely evident that the outside man must *walk round*, as the pivot man *turns round*, and can do no more. He can't turn on his axis besides, because of the "fixed bayonet" in his side which holds him. Consequently he can't turn his face always to the north till you unfix the bayonet and let him turn one way as he goes another.

Finally, paint a world in the centre of a whirling table and a moon at some point near its circumference. The same side of the painted moon will always look to the centre as the table revolves. But can it turn on its axis *in addition* to turning round with the table? Or —one more last word—hold an orange in your hand with extended arm, turn round on your heel, and the orange goes round with you, always presenting the same side to your face. In order to make it keep the same side always towards the north you must turn it on its axis as it turns round you.

10 March, 1864. NAUTICUS.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—Allow me through the medium of your pages, to recommend the following experiments to be tried by those of your readers who are interested in the "Moon's Axial Rotation" Controversy.

I suppose it is allowed that the moon turns round the Earth once in a month, and that it keeps the same side towards the Earth. The point to be determined, without hair-splitting about the meaning of rotation &c., being whether or not the moon turns round itself during the same period.

1st. Place your finger on the page near to this spot (.) with the inside of the finger towards the spot, then without taking the finger from the page turn the finger all round the spot keeping the inside of the finger towards the spot: it will be found that in doing so the finger has to be turned round itself.

2nd. Walk round the outside of any square—a patch in the garden, Lincoln's Inn Fields, or a square table—in doing so the same shoulder will be kept towards the centre of the square; at the first corner thereof a very sensible turn, a quarter round, of the body will take place; at the second third and fourth corners a similar quarter turn will take place, so that when you come to the side whence you started you will have turned round the centre of the square, have kept the same side towards the centre of the square, and have turned round yourself. In walking round an octagon you would do precisely the same thing, with eight personal small instead of four large turns; and in walking round a circle you would do the same thing, only the personal turning would be distributed over every step taken.

How do those who deny that the moon turns round itself, get out of the following dilemma? The light of the sun traverses round the surface of the moon once in a month. In order to produce this effect, either the moon must turn round itself once in a month, or the sun must turn round the moon once in a month. The former Cyclops and Co. deny, the latter who does not deny?

I am, sir, your obedient servant,

I. M. SIMKISS.

Wolverhampton, March 9th, 1864,

TO THE EDITOR OF THE ASTRONOMICAL REGISER.

Sir,—No one, I presume, contends that the moon is not turning round. All revolving bodies must turn round once at every revolution. However, as there appears to be some unaccountable misapprehension on the question of the moon's motion, I beg to request your correspondents' attention to the following definitions:

Rotation, according to the terms employed in dynamics, means the act of turning round a centre situate *within the body*. Hence a rotating body cannot constantly present any given part of its circumference to any place beyond itself, unless such a place revolves round it. A man whirling on his heel rotates, and would present, in so doing, every part of his body to any given point.

Revolution is the act of turning round a centre, not *within*, but *without*, or *beyond* the moving body. It is not a whirling, or a spinning motion, but a *progressive motion in a circle*. A horse going round a circle revolves, and by revolving keeps constantly the *same side* towards the centre of his circular path; hence he turns round once at each revolution, and although he constantly presents the same side to the centre of revolution in which he turns round, yet he shews both sides to every place beyond the circle. The governor balls of a steam engine turn round by revolving, but have no rotary movement on internal axes.

Parallel Motion. This is a compound movement. The connected rods of the wheels of locomotive engines present parallel motions. The extreme ends of the rods are *carried round* circles by the crank-pins, yet they do not *turn round*, much less rotate or revolve. A magnetic compass placed in the rim of a moving horizontal wheel would, like the connected rod, retain the parallelism of the needle, whilst the *case* of the needle would turn round once in each revolution of the rim, but neither the rim nor the case turn on any other axis than the centre of revolution. Some persons are under the impression that a body cannot turn round unless it rotates, and again imagine that a body can revolve and yet retain its parallelism, like the end of a connecting rod. When geometricians discuss such questions it is expected that they should be correct in their definitions and the terms employed, yet we frequently observe *rotation* and *revolution* used as synonomous terms. Kepler observed that the moon "has not been endowed with rotation;" I ask, with all due deference, Mr Dawes, how subsequent geometricians and astronomers gave the moon credit of another movement, or double motion?

I am yours obediently,

E. HOPKINS. C. E. F. G. S.

15, Clarendon Gardens, Maida Hill. W.
March 16th, 1864.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir—I would take this opportunity of correcting two small errors in the printing of my letter on the Moon Controversy, which you did me the favour of inserting in the Register for this month. On page 61, line 13 from the bottom, for *next* read *west*. And on page 62, line 1, for *rotatory* read *rotating*.

The word *rotatory* is often used, though erroneously, for *rotary*: but the meaning of the two words is very different. *Rotary* has a *neuter* signification, *turning as a wheel*. The wind is the *rotatory power* which causes the *rotary motion* of the sails of a windmill. *Rotatory* is not found in Johnson's dictionary, or in Walker's, but in Webster's it is inserted; and he says of it, "This word is often used, probably by mistake for *rotary*...............With *rotator* for its original, it would signify *causing*, rather than *being in* a circular motion. The true word is *rotary*."

I am, sir, yours very truly,

W. R. DAWES.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—The contest in America has been protracted until we have nearly ceased to feel an interest in it, the public mind already wearies with respect to the Schleswig Holstein affair, so the Lunar controversy may become tedious even to such enthusiastic men as are numbered amongst the readers of your valuable Register. Permit me therefore, to check further disputes by tending my services as legal referee. In this capacity I shall commence by quoting precedent; the first, and only one to which I shall allude, is the famous Oyster case; guided by the verdict of the learned Judge on that occasion, I award to each of our combatants a shell apiece; it would be unbecoming in me to say any thing about the fish itself.

In framing an award it is unusual to state reasons, but if I may now make an exception I should say to our friends, you both are right, and with nearly equal force I might add, you both are wrong; for herein is the centre and pivot upon which the whole argument revolves—with reference to bodies outside of her orbit the moon *does* turn upon her axis, but with reference to the earth she *does not.*

Your obedient Servant,

LEGISLATOR.

March, 1864.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—Will you allow me, through the medium of your interesting publication, to put a few questions to those of your readers who have made the rotation of the moon a matter of thought and study. It has recently been discovered, that the surface of the moon which is turned towards the earth, projects beyond a true cone of the sphere; that it is, therefore, in the condition of a vast mountainous elevation.

Question I.—Has this figure any connection with the fact that its axial rotation agrees with its orbitual period?

Question II.—Is it possible that this figure is simply the final state of that tidal wave, which, according to the theory of the original fluid state of spherical bodies, must have existed on its surface in consequence of the powerful attraction of the earth?

Question III.—Is it possible that the moon at one period possessed a more rapid rotation, and that this wave, acting in the mass of a gradually cooling body, performed the office of a continual drag, reducing the revolution at last to *nil*, thus binding that hemisphere in which it came to its final rest, perpetually to the earth?

These are interesting questions in consequence of their bearing on the satellites of other planets, or even the line of rotation of the planets themselves, and any answer will be thankfully received by

AN AMATEUR.

2, Melbourne Place, St. John's Wood Road.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—I am told that "two eyes" and "one eye" are discussing in your columns the question whether the moon rotates; will you allow a blind man to hold the balance between them, and give the sum of the whole matter?

Conceive the moon under the influence of one force only, it would move in a straight line, and, to use the elegant and forcible language of "Cyclops," it would "follow its nose." Let "Cyclops" get astride of the moon's nose, and planting the legs of his telescope-stand deeply in the substance of its nose, direct his telescope to a star before him. As long as the moon continues to advance in a straight line, the star would appear immoveable in the centre of the field. Here there is no rotation. Now let the earth's attraction come into play. As the result of the composition of forces, the moon leaves

the straight line and now moves in a curve, and in this curve both "two eyes" and "one eye" must agree it will still "follow its nose." What will "Cyclops" who is a-straddle the nose see through his telescope? The moment the moon felt the earth's attraction the star he was looking at went out of the field. And if he be compelled to keep his one eye at the telescope during a whole revolution, a very suitable penance, he will see a series of stars sweeping past forming a great circle in the heavens. "That is it," cries "two eyes." "Cyclops has himself rotated at last!" "No," says Cyclops, "I have not turned at all, and I will prove it." So he wriggles himself off the moon's nose, and uprooting his telescope, he gets along somehow round the moon's cheek, and now gets astride the ear of the moon, and turns his telescope towards the earth. He directs it upon the most conspicuous object as seen from the moon, which is doubtless the office of the "Astronomical Register," and during a whole month Cyclops counts up backwards and forwards the twenty letters in that golden name. "There," says Cyclops, "now I have proved it, the moon does not rotate."

Hear a blind man's sum of the whole matter. The moon is not a mathematical point. When the moon was moving in a straight line take three distinct points in it, one at the centre and two at the circumference, forming, if joined, a diameter at right-angles to the direction of its motion. Now when the earth attracts it, all these points move in new directions; as before, their separate paths were parallel to each other, so now they form parts of concentric circles, and a necessary result is that this diameter continues at right-angles to the new direction of motion. As this new path is a circle the diameter must relatively to outer space shift round once during each revolution. "There," says "two eyes," "the moon does rotate." "No," says "one eye," "it doesn't, *because this is the necessary result of revolution.*"

The blind man leaves it to the reader to determine whether an effect, a result, is, or is not, to be judged by its cause. Let "two eyes" suddenly pounce upon "one eye" from behind, and forcibly turn him once upon his axis. Then afterwards let "one eye" voluntarily turn himself once round upon his heel. There is a similar effect produced by two different causes; does "one eye" rotate in the latter case only, and not in the former?

I am, sir, yours, &c.,

CUI LUMEN ADEMPTUM.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Mr Editor—In this part of the heavens we are all much amused by the extraordinary notions you have about our little globe and its movements, having been informed of the discussion by means of the new *Lunar telegraph*. We have had many a laugh at the clever people on the Earth who will insist that we rotate on an axis in the same manner as that body. Why, a cousin of mine, who lives at the other side of the moon, sometimes makes a journey round to this side on purpose to see the earth! which his neighbours who do not take this trouble, never behold. I do not think you people who live on the other side of the earth are obliged to travel round it in order to see us—are you? No—the rotation of your globe brings you round to us, while the *non*rotation of ours compels us to travel round to see you.

I am, Mr Editor, yours to command,

THE MAN IN THE MOON.

Mare Humorum, April 1864.

[We should be glad to see the "Moon Controversy" drawing to a close, although from the quantity of letters we have received it appears to possess a large amount of interest to a great number of our subscribers. And we must here protest against the *tone* of some of our correspondents' letters on this and other subjects; and beg them *to confine themselves strictly to the points in question.* We cannot in future admit any letters containing personal remarks.—Ed.]

TABLE OF DOUBLE STARS,

Right Ascension, Ten and Eleven Hours.

CLASS I.—Division 2.

Stars from the 1st to the 7th Magnitude,
From 8" to 20" apart.

Name of Star, &c. Magnitudes & Distance. Position Angle.	Right Ascension and Declination.	Remarks.
17 Crateris .... 5½—9"—7 211	11 25 35 —28 31	

CLASS I.—Division 3.

Stars from the 1st to the 7th Magnitude,
From 3" to 8" apart.

54 Leonis .... 4½—6"·2—7 103	10 48 15 +25 28	

CLASS II.—Division 1.

Stars from the 7th to the 11th Magnitude,
From 20" to 180" apart.

a Leonis *(Regulus)* ...... 1—176"—8½ 307	10 0 20 +12 38	
159 P. x. Hydræ ...... 8—31"—9 10	10 41 0 —14 55	
β Ursæ Majoris .... 2—75"—11 173	10 53 35 +57 6	
φ Leonis .... 5—105"—8½ 285	11 9 45 — 2 55	
83 Leonis .... 8—30"—9 151	11 19 55 + 3 45	
170 P. xi. Leonis ...... 7½—35"—9½ 13	11 45 45 +16 12	

CLASS II.—Division 2.

Stars from the 7th to the 11th Magnitude,
From 8" to 20" apart.

179 P. x. Leonis ...... 8½—11"·8—9 306	10 45 10 + 8 10½	
39 P. xi. Crateris ...... 8½—8"—9 315	11 12 55 — 6 9	

A TABLE OF RECENT COMETS.

BY G. F. CHAMBERS, ESQ.

No	No	Year	P P			π	Ω	ι	q	ϵ	μ	Calculator	Date of Discovery	Discoverer	Duration of Visibility
				d.	h.	° ′	° ′	° ′							
272	218	1861 i	June	3	4	243 3	29 51	79 55	0·9215	0·99388	+	Pape	1861 Apl. 4	Thatcher	8 weeks
273	219	— ii	June	11	12	249 4	278 58	85 26	0·8223	0·98533	+	Seeling	— May 13	Tebbutt	12 months
274	220	— iii	Dec.	7	3	173 30	145 6	41 57	0·8391	1·0	−	Pape	— Dec. 28	H. P. Tuttle	8 weeks
275	(100)	1862 i	Feb.	6	4	158 0	334 30	13 5	0·3399	0·84670	+	Powalky	— Sep. 28	Förster	17 weeks
276	221	— ii	June	22	1	299 20	326 32	7 54	0·9813	1·0	−	Seeling	1862 July 1	Valz	4 weeks
277	222	— iii	Aug.	22	22	344 41	137 26	66 25	0.9626	0·96116	−	Oppolzer	— July 15	Swift	13 weeks
278	223	— iv	Dec.	28	3	125 9	355 44	42 22	0·8025	1·0	−	Engelmann	— Nov. 30	Bruhns	3 weeks
279	224	1863 i	Feb.	3	12	191 22	116 55	85 22	0·7947	1·0	+	Engelmann	— Nov. 28	Respighi	15 weeks
280	225	— ii	April	5	0	247 15	251 16	67 22	1·0682	1·0	−	Raschkoff	1863 Apl. 11	Klinkerfues	6 months
281	226	— iii	April	20	21	304 47	250 10	85 29	0.6288	1·0	+	Frischauf	— Apl. 12	Respighi	5 weeks
282	227	— iv	Nov.	9	12	94 43	97 29	78 5	0·7066	1·0	+	Oppolzer	— Nov. 4	Tempel	16 weeks
283	(147)	— v	Dec.	26	14	59 13	304 57	63 35	0·7661	0·94590	+	Weiss	— Dec. 28	Respighi	8 weeks
284	228	— vi	Dec.	29	4	183 8	105 1	83 18	1·3131	1·0	+	Engelmann	— Oct. 9	Bäcker	6 months

REMARKS on the Preceding TABLE of COMETS.

272 Visible to the naked eye; it had a faint diffused tail 3° long: an elliptic orbit; period assigned 1848 years.

273 One of the most magnificent comets on record: on July 2 its tail was more than 100° long. An elliptic orbit; period assigned 419 years.

275 An apparition of Encke's comet.

276 Discovered by Schmidt and Tempel on July 2; on July 4 it had a tail ½° long, and was then visible to the naked eye: between the 3d and 4th it traversed 24° of a great circle.

277 Discovered by H.P.Tuttle and Simmons on the 18th July; by Pacinotti on the 22nd; and by Rosa on the 25th. Conspicuously visible to the naked eye for two or three weeks in August—September, with a tail on August 27 as much as 25° long, according to Schmidt. An elliptic orbit: period assigned, 123 years.

282 Discovered independently by J.F.Schmidt on Nov. 12. Visible to the naked eye as a star of mag. 4, with a tail 2° or more long.

283 Discovered also by Bäcker on Jan. 1, 1864: visible to the naked eye, with a tail ½° long at the end of January. Believed to be a return of the comets of 1810 and 1490.

284 Discovered by Tempel on Oct. 14.

The preceding Table is offered in reply to G.J.W. The method of arrangement is that which I have adopted in another place, where an explanation of the symbols will also be found. The elements for the two last comets are only provisional. G.F.C.

TO CORRESPONDENTS.

N. B.—Articles received after the 20th of the month cannot be inserted, unless containing notices of fresh discoveries, or otherwise of immediate interest.

Communications from A. L. S.—A. W. Deey—M. A.—and H. in our next.—Our List of Instruments for Sale is omitted for want of space; it remains however the same as in the last number.

List of Subscribers.

NAMES RECEIVED SINCE OUR LAST NUMBER.

Crowe, Rev. R., Woodhouse Parsonage, Huddersfield.
Ward, W. Esq., 5 Albert Terrace, Aulaly Road, Hull.
Wilson, C. Esq., Calder Mount, near Garstang, Lancashire.

ASTRONOMICAL REGISTER—*Subscriptions received for the year* 1864—the Editor's list.

To **March.**
Jefferies. J.

To **June.**
Banks, W.L.
Bird, F.
Birt, W.R.
Burr, T.W.
Crowe, Rev. R.
Deey, Rev. A.W.
Goode, H.S.
Green, N.
Ingall, H.
Jackson, Mrs H.
Johnson, R.C.
Knight, Rev. D.T.
Noble, Capt. W.
Romberg, H.
Sargent, Rev. J.P.
Virtu, J.
Wolley, Rev. J.

To **September.**
Hunt, G.

To **December.**
Adams, S.
Banks, R.
Fraser, J.
Hopkins, E.
Potter, Rev. T.J.

April 27, 1864

Those Gentlemen who have not yet sent their subscriptions for 1863 are particularly requested to do so.—The Subscription up to June 1864 is due.

CONTENTS.

The Astronomical Register.

No. 18. JUNE. 1864.

MR. NASMYTH ON THE MOON.

A very interesting lecture was given on the evening of Friday, May 20th, at the Royal Institution, by James Nasmyth, Esq., on "Day and Night in the Moon." The lecturer pointed out that while, in order to visit distant places on the earth, we had to subject ourselves to a variety of inconveniences incident to travelling, we might, on the contrary, view the moon without leaving our houses; and not that only, but, from the varying degrees of illumination on its surface day by day, we could see the objects thereon under every possible variety of aspect. After adverting to the nebulous theory, and the incandescent and molten state of the planetary bodies, Mr. Nasmyth described the powers of volcanic action, and stated that in the moon, in the ring-formed mountains and central peaks, we found almost absolute evidence of former volcanoes, but "that their action had ceased myriads of ages" ago. If observers of the moon's surface would bear in mind the exceedingly great antiquity of what they see on the surface of our satellite, it would give them additional interest in the sight of such a ruin of nature. The reason why neither air, water, nor wind was to be found in the moon, was pointed out; also the extraordinary blackness of the shadows and of the sky; no atmosphere tempering the sun's rays; a lengthened day of intense heat being succeeded by an equal interval of night, at a temperature 300 degrees below zero. As it might be asked, what was the use of the moon? he showed that it acted as the universal scavenger, by causing the tides of the ocean, —the daily flow of which prevented that universal stagnation of matter on the earth, which otherwise would cause it to be almost

uninhabitable. He also adverted to the "carrying powers" of the moon, saying, that by its causing the daily flow of tides in the rivers, it was of infinite use in bringing up barges and vessels without other aid. The lecturer concluded by an experiment to illustrate the formation of those extensive cracks which are seen to radiate from certain centres all over the surface of our satellite: a glass globe being filled with cold water and hermetically sealed, was immersed in a pail of warm water,—this caused the cold water to expand and the globe to crack, and portions of the broken vessel being exhibited by means of a lantern on the screen, showed the most beautiful and delicate lines of fracture radiating in a similar manner to the fissures on the moon. This, the lecturer stated, was a proof that the moon's surface, which had become solidified first, had been cracked by the heated matter within expanding as it cooled. The lecture was illustrated by beautiful drawings of the craters; by models of the surface; by two small globes of proper size, and suspended at a proper distance, to show the relations between the earth and the moon; and lastly, by an exhibition on the screen of one of Mr. De la Rue's beautiful lunar photographs.

ROYAL ASTRONOMICAL SOCIETY.

Seventh Meeting, 13th May, 1864.

Warren De la Rue, Esq., F.R.S., *President*, in the Chair.

Secretaries, Rev. C. Pritchard and Mr. Hodgson.

Thirty presents were announced, including two volumes of drawings of solar spots since 1859, from the Rev. F. Howlett, before which, Mr. Pritchard said, the others "paled their ineffectual fire;" and the President remarked that no such drawings as to both quantity and quality had been made before, as far as he knew.

Capt. J. P. Basevi,
A. Escott, Esq.,
H. P. Finlayson, Esq., and
R. J. Newall, Esq.,

were balloted for and duly elected Fellows of the Society.

The following eminent names were proposed as Associates:—

Dr. Donati,
Professor Luther, and
Dr. R. Wolff.

—A paper from Mr. Pogson, *On the Asteroid lately found by him at*

Madras; the purport being to decide whether it was a new planet, Sappho (80), or one that had been observed before.

On the Transit of Venus, December 1882, by the Astronomer Royal. Alluding to what he had said at a former meeting with reference to this transit as a means of determining the distance of the sun, Mr. Airy in this paper pointed out what conditions would enable us to fix on the part of the earth where the parallactic effect will be at the maximum. The writer thought it ought not to be long before investigations were made as to the practicability of Sabrina Land for these observations; and if this place should appear inadvisable, what other part would be applicable.

A paper by Mr. A. S. Herschel *On Shooting Stars,* being a continuation of that read at the last meeting.

Mr. Pritchard observed that it might be called a singular confirmation of the theory in these papers, that the excess of meteors actually observed in March over those seen in September agreed with the theoretical number.

The President observed that with regard to the transit of Venus, it showed the care which Mr. Airy took to be beforehand with his work, that here was an elaborate paper preparing the way for an observation to be made eighteen years hence.

On the Satellite of Sirius, by M. Otto Struve. Although Mr. Safford considers that the small star is not in connection with Sirius, but that its accidental juxtaposition is far more probable, M. Struve scarcely regards this as established, Sir Wm. Herschel never having observed the small star where it then would have been seen, although he used Sirius as a test for his telescopes. The best measures gave $10''\cdot3$ for distance, and $5^{\circ}\cdot7$ for position; but there were discrepancies which, however, might be due to the prismatic appearance of Sirius, owing to its low altitude at St. Petersburg.

The Rev. W. R. Dawes said, that as to seeing the companion of Sirius, he had seen it twice, but could say no more than that. It was best seen in strong twilight, which showed that it was pretty bright, but obscured by the blaze of the larger star at night. If it had a higher altitude, we should see it without difficulty. He thought its being the representation of Bessel's invisible body rather hypothetical at present.

Mr. Dunkin read a paper *On the Probable Error of Meridianal Transit Observatians by Eye and Ear, and by the Chronographic Method.* Enquiries having been made by visitors at Greenwich as to the relative merits of the systems, Mr. Dunkin determined to test the matter. His impression was, that the galvanic method was most advantageous with moderate stars, as of the 5th and 6th magnitudes; but the result was different, showing the advantage to be nearly

uniform. He took 1,200 transits, ranging from the 1st to the 6th magnitudes, but leaving out a few of the very brightest 1st magnitude stars, as not being well adapted for observations at night. The mode of discussing these observations was described and the results of the comparison given in great detail. Thus for transits over a single wire, the errors were for 4 magnitudes, as follows:—

	1.	2.	3.	4.
Eye and Ear	s·0·074	0·079	0·076	0·084
Galvanic	0·053	0·050	0·053	0·052

while for a complete transit of a 1st magnitude star the error by the old plan would be 0·028, and by the new 0·018. As might be expected, the probable error increased as the N. P. D. diminished; and it was also a remarkable result that the personal equation between different observers, which was subject to variation under the sight and touch arrangement, was singularly constant in observations by the galvanic system, and was in all cases lessened in quantity.

The President complimented Mr. Dunkin on the energy which led him and the Greenwich observers to undertake so many laborious amateur investigations in addition to their professional work, and said that when it appeared that the place of a star was found to one-third of a second by ordinary transits, and to one-fourth of a second by the chronograph, it seemed idle to look for greater accuracy; but he must draw attention to Professor Wheatstone's plan, in which it was proposed to have a wire, made to travel by the observer across the field of view at the same rate as the star, touching the wires when the star crossed them, and communicating with the chronograph in such a way that the contacts might be recorded automatically, and the accuracy thus increased. He (the President) thought this quite feasible, as he had first made photographs of the moon, with good effect, by following its motion by hand; but he suggested that Wheatstone's method might be improved by having the movable wire carried by clockwork.

Colonel Strange said that the question possessed the greatest interest to him, having to order instruments for determining the Indian longitude, and he therefore went to Paris to gather opinions as to the two methods. He found the French astronomers had decided against the chronographic method: Leverrier said "it would make bad observers." It was necessary, when dealing with such very small quantities, to multiply the observations. He thought the French astronomers, in comparing the two plans, did not make observations enough. A second of arc is now a gross—a huge quantity: we now get to the second or third places of decimals of a second. He had preferred Mr. Airy's plan to M. Leverrier's opinion, and ordered a complete chronographic apparatus. The method suggested by the

President, of a movable wire carried by machinery across the field of view of the telescope to make the transit, has, however, been achieved. At the meeting of the Society on the 8th of January last,* he (Colonel Strange) had described an invention by M. Redier for the very purpose, and transits were now recorded at Paris in this way with the greatest success. Mr. Dunkin's paper to-night quite settled the question of the two methods of transit-taking.

Mr. Walker said that at one time he asked himself the question, what was the use of electricity? Mr. Dunkin had given an answer to this, and had this evening told us how completely it is the servant of observers. Observations by this agent are the most accurate of any obtained; and the apparatus is now brought to such perfection, and obeys so thoroughly, that we get all the results Mr. Dunkin has related to us. It is gratifying to an electrician to find that the subtle element he deals with is able to render such assistance to astronomers.

In answer to a question, Mr. Dunkin stated that those who now observed with electricity, if from derangement of the apparatus they were obliged to go back to the old way for a time, observed as well as, or better than, before.

Mr. Pritchard called to mind that half a second of arc was but equal to *a hair at the distance of* 125 *feet;* or, as Colonel Strange added, four inches at the distance of a mile equalled one-third of a second, or a foot a whole second.

Mr. Talmage, *On the Appearance of the Solar Disc.* Since 1861 the writer had examined the sun with apertures of 4, 6, and 8 inches, and powers from 40 to 500, and up to 1863 omitted no opportunity of so doing; but during the whole time had never seen either willow-leaves, rice-grains, or thatch. All he saw was a difference of greater or less luminosity.

A paper by Mr. Drach, *On the Analogy between some Forms of the Solar Spots, and certain Curves, entitled "Bicircloids," delineated by Mr. Perigal.*

The Rev. W. R. Dawes then read a paper entitled *Results of some recent Observations of the Solar Surface, with Remarks.* The state of the air having been unusually favourable during parts of four days in April, advantage was taken of it to institute a very careful examination of the solar surface, with special reference to some points of great interest connected with recent discussions.

1. To ascertain whether in any part of the photosphere any objects could be found which could properly be compared to *willow-leaves* in their form.

A difficulty has always been found in devising an appropriate appellation for the small bright irregularities of the surface, which should

* See *Ast. Reg.*, vol. ii. p. 32.

not assume anything as to their character, or their uniformity of shape. The term "willow-leaves" appears to be quite inapplicable. Mr. Stone's "rice-grains," though far less objectionable, implies a uniformity of size and figure they do not possess. But Mr. Dawes has been led by it to apply the term *granulations*, or *granules*, as assuming nothing definite which does not exist; and he ventures to propose the term on that ground. In a tolerably favourable state of the air there is no difficulty in distinguishing these little bright objects; and whenever they have not been pretty distinctly visible, Mr. Dawes has always abstained from further scrutiny as useless.

As it has been imagined that the use of the very small fields of view in Mr. D.'s solar eye-piece may be incompatible with perfectly distinct vision, in consequence of the diffraction of light at the edges, it may be proper to state that the smallest field has a diameter of 15″, of which the central 10″ at least are perfectly free from distortion. Yet, in the present investigations no smaller field than nearly 1′ has been employed; and the objects were always seen with the utmost distinctness when the state of the air would permit.

Various portions of the surface were diligently examined with powers from 131 to 407; and the granulations were easily seen in all parts not very close to the edge of the sun. They were found to vary greatly both in form and size. Among some hundreds, not one was met with which could fairly be compared to a willow-leaf, the rarest of all forms being the long and narrow; and some were noted as being four or five times as large as others near them. On the whole, the evidence seemed convincing that they were not individual or separate bodies of a peculiar nature, but only different conditions as to brightness or elevation of the larger masses which form the mottled surface: just as the brighter portions of that surface, and the *faculæ* also, are different conditions of the general photosphere. Nothing was met with resembling the *interlacing* which Mr. Nasmyth has so clearly described and so distinctly depicted as being the characteristic of the whole solar surface. If this statement is withdrawn, and the peculiar willow-leaf shape of these objects is given up, as seems now to be the case, there remains nothing like a new *discovery* at all; for the *granulations* have been observed for many years as an integral part of the solar surface, and are in fact not difficult to see.

In the darker lines between the granules were distinctly seen in many places dark dots, like *stippling with a soft lead pencil*; constituting the "pores" of Sir John Herschel, and the "punctulations" of his father.

On the *penumbræ* of the spots then visible were several long and narrow bright lines, like bits of thread, extending completely across the whole breadth of the penumbra without any break, and also

smaller pieces, but nothing which could suggest the comparison to a willow-leaf. Variety of form and size was the most striking feature here, as well as on the general surface.

2. A second object in the scrutiny was to determine whether these bright granulations extend equally to the brighter and to the shaded masses composing the coarse mottling of the photosphere. The result was, that the granules were in general both smaller and less bright on the shaded masses than on the brighter ones. It is a remarkable fact, that on each of these larger masses the individual granules are all very nearly of *equal* brilliance throughout the mass to which they belong.

3. A third principal object was to ascertain whether the brighter parts immediately surrounding the penumbræ of spots were granulated like the rest of the surface; and also, whether such a feature were discernible on the *faculæ* as seen near the edges of the sun's disc. The reality of these brighter regions (specially adverted to in a former paper) is fully confirmed by photographs taken by our President. No granulations were discovered on them. The commotion which causes these apparently heaped-up and brighter regions seems to confound and destroy the delicate distinctions easily seen elsewhere. Precisely the same result attended the examination of the *faculæ;* which thus possess this additional evidence of having been thrown up in ridges by some disturbance of the general surface.

The President held that Mr. Nasmyth's discovery was a substantial one, and that what he had seen were distinct entities on the sun, not before noticed by other observers. He (Mr. De la Rue) was having apparatus fitted up for these observations, and hoped to have further opportunities of investigation.

Some good-humoured remarks passed between Mr. Dawes and Mr. Stone, who objected to the term "optical illusion" used by the former in his letter read at the last meeting; and Mr. Stone said that if Mr. Dawes was such an old bird as not to be caught with chaff, he had, sixteen years ago, when he saw these appearances first, passed by some excellent game.

Mr. Dawes explained that the term "optical illusion" had reference merely to the difference of objects seen with high and low powers, Mr. Stone having spoken only of powers of 40 and 60.

Col. Strange, alluding to the difference in microscopic objects when seen with different instruments, thought that Mr. Dawes and Mr. Nasmyth ought to observe the same object with the same telescope.

The Rev. F. Howlett said, that if his drawings were referred to, the bright part round the penumbra of spots would be found, and also that there the bright mottlings were not so distinct. He again recommended the use of a screen for these appearances, upon which

the mottlings could always be seen distinctly; but, in his opinion, these were *not* the willow-leaves, but aggregations of such bodies. He referred to an eye-piece, recommended by Sir J. Herschel, consisting of a crown-glass double convex and a meniscus flint lens, as being both aplanatic and achromatic, and read some extracts from a letter of Sir John's on the subject.

Mr. Pritchard said that the eye-piece in question, instead of being a difficult one to make, was quite the reverse; so much so, that even if an error were made in its construction, it would still act very well.

A paper by Mr. Bonomi, *On the Astronomy of the Ancients as shown in certain Drawings on an Egyptian Sarcophagus*, concluded the meeting, which was very fully attended.

CORRESPONDENCE.

N.B.—We do not hold ourselves answerable for any opinions expressed by our correspondents.

THE CLOSE DOUBLE STAR NEAR CASTOR.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—The close double star near Castor, B.A.C. 2489, to which Mr. Bird calls attention in the last number of the *Register*, is No. 175 of the Poulkowa Catalogue, where it is described as composed of two stars of the 6th and 6·7th magnitudes respectively, with a central distance = 0″·6. The Rev. W. R. Dawes informs me that in the second edition of the Catalogue the distance is given as 0″·5, which is in better accordance with his own estimations.

The star is, unfortunately, too far advanced into the twilight to admit of satisfactory measurement; but I have managed to secure three sets (not very accordant, I am sorry to say) with my 7⅓ inch equatorial and magnifying powers 375 and 515, yielding as a mean result P = 345°·4; D = 0″·5 est. Epoch 1864·36. The components appear to me to be slightly unequal; and there is a small star at some distance to the south, a little preceding.

Is there a misprint in the Angle of Position of Mr. Bird's small double star following Procyon, as given by Mr. Romberg in the April number of the *Register*? Mr. Romberg gives P = 134° 9′; my own estimations give P = 200°, which is in fair accordance with the value assigned by Mr. Dawes.

I am, Sir, yours faithfully,

GEORGE KNOTT.

Woodcroft Observatory, Cuckfield:
May 19th, 1864.

SOLAR OBSERVATIONS WITH NEWTONIAN REFLECTORS.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—I would suggest to any of your readers who are carrying on solar observations with reflectors of the Newtonian form, to try the effect of a glass "flat," unsilvered, and mounted in a light skeleton frame, leaving the back of the glass quite open to admit of the escape of the heating rays: the screws, two bearing and three for adjustment, to be set in the margin of the frame.

I have just adopted this arrangement with admirable results. I had the sun in the field of view, with the full aperture of 12 inches of my silvered glass speculum, to-day for nearly an hour, without perceiving any undue heat or other inconvenience, with a cloudless sky, and the thermometer standing at 83° in the shade at the same time.

It is the general impression, I believe, that unsilvered specula are necessary for viewing the sun with safety and comfort. I can confidently say that nothing more need be unsilvered than the glass flat, if the back be left open, to view the sun with perfect impunity with any aperture up to 12 inches, and for any length of time.—I am, Sir,

Yours faithfully,

F. BIRD.

Key Hill, Birmingham:
May 20, 1864.

EARL ROSSE'S TELESCOPE.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—Can you give me any information with regard to the fine instrument which was constructed by the Earl of Rosse some few years since? I have a vague idea that the instrument is out of repair or out of action from some alteration in the figure of the speculum. We have not heard of any discovery lately made by this noble instrument, which every lover of science must much regret.—I remain, yours,

READINGENSIS.

May 10th, 1864.

ON THE APPARENT VARIATION IN THE SUN'S DIAMETER, MEASURED IN THE MERIDIAN IN DIFFERENT LATITUDES.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—It is well known, since the time of Kepler, that the sun appears less in the month of June than in the month of December, when observed

in Europe. For instance, at Greenwich, say latitude 51° 28′ 38″ North, the angular diameters appear in—

	°	′	″		′	″	
June .... ∠	61	58	30	......	31	30	Sun's diameter.
Sept.	38	31	22	......	31	58	„
Dec.	15	3	50	......	32	36	„

In taking observations at a corresponding latitude South, near the Straits of Magellan, the following results have been obtained:—

	°	′	″		′	″	
Dec. .... ∠	62	0	0	......	31	30	Sun's diameter.
March	38	30	0	......	31	59	„
June	15	4	0	......	32	36	„

Consequently, the sun appears less in December than in June to the inhabitants of the southern hemisphere, and totally different at corresponding periods to the variations seen in Europe.

The sun, when measured in the zenith within the tropics, appears the same size all round the year, namely—

30′ 36″; and in the horizon, about 32′ 55″.

At an altitude of about 22°, the sun's diameter is at all times of the year, and in both hemispheres, 32′ 32″.

Hence it follows that the variable diameter of the sun is caused by our atmosphere, and is not the effect of variable distances. This fact may be confirmed at our Observatories at the Cape of Good Hope and in Australia.

E. HOPKINS, C.E.

May 18th, 1864.

LIGHT AND DARKNESS.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—In dealing with questions such as that proposed respecting *Darkness*, by "*Readingensis*," in your number for February last, we must be careful not to ascribe reality of existence to mere privative terms. "Darkness," like the similar *negations* of coldness, silence, void, lightness, &c., can have no actual existence except in a *relative* sense. As such, it is *shadow* in respect of greater light, but *light* in comparison with intenser darkness.

The sun and fixed stars, we should hold in mind, are only *luminaries* (φωστῆρες), or *bearers* of light, which they concentrate on their respective photospheres from a state of universal diffusion in space, where the rays, whilst passing separately and in parallel lines from their mysterious and latent sources, would probably without such concentration be altogether invisible. * The light and heat of the earth, now converged by its atmospheric lens from the solar photosphere into their present *comparative* power (as has been clearly shown by Mr. Evan Hopkins, F.G.S., in his work on "Terrestrial Magnetism"), would, if not so condensed, probably possess no greater intensity than the delicate "*ashy* light" on the new moon alluded to by your Correspondent, and which, when seen in contrast with the stronger and increasing solar light on her surface, fades away so rapidly into the invisibility of the surrounding space.

We know nothing of the nature and phenomena of light, except as seen through an atmospheric medium; but could we look at this surrounding

* This ordinary solar light and heat are but shadow and coldness in comparison with that state of *incandescence* to which they may be further intensified by convex lenses.

space from some spot free from atmospheric conditions, it would doubtless present that appearance of *blackness* now observed in more elevated and rarefied regions of air, and the sun be scarcely more perceptible than the "lumière cendrée" of the moon.

Still, however, so long as this darkness is modified by the smallest admixture of light, it must retain its *relative* character. All conception of darkness in a more abstract and absolute sense would be *ideal*, or mere *nominalism*.

In what way the light of any of the heavenly bodies can be reflected, as it now is, from the moon's spherical surface without a lunar atmosphere, except as a mere radiant *spot* of light (like that in a globule of glass or mercury, or from the pupil of the eye), subtending perhaps too small an angle to be visible at all, seems to need explanation.

We have of late years, on new and more trustworthy data, been modifying and correcting our scientific views in regard to the "corpuscular theory of light," and more recently the "sun's distance from the earth;" and I can see no reason why, in these days of general revision, when the first principles even of our *religious* faith are passing through a fresh ordeal, we should be sparing of discussion on such debateable questions as those of a "lunar atmosphere," "the ellipticity of the earth's orbit," &c., the former of which has been shown, in the work above mentioned, to be, at least on optical grounds, not improbable, and the latter an optical illusion.

With every conservative feeling towards established and time-honoured truths, I cannot conceive it consistent with the real interests of science, or truth generally, that these and similarly-controverted questions should be ignored or left to desultory criticism by those who are competent, by more systematic reasoning, to place our astronomical knowledge on a firmer basis than it now appears to be.

I am, Sir, yours very faithfully,

April 18th, 1864. M. A.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—A very humble follower of such men as Airy, Arago, Brewster, Fizeau, Foucault, Herschel, Potter, and Stokes, I should be the last man in the world to arrogate to myself the title of "Sir Oracle": I am content to leave such presumption to those who "view scientific facts otherwise" than as they have been explained and exemplified by men of the eminence of those referred to.

To the first query of "Readingensis," in his letter of March 22nd, regarding a beam of light, it is only necessary to answer that, consisting, as light does, of undulations propagated through a subtle medium, such undulations can never become perceptible until they impinge upon the retina. And the next, having reference to the appearance of the sun as viewed from above our atmosphere, may find its reply in almost any one of the published accounts of the ascents of very high mountains, or in balloons—showing that, even at a very few miles above the surface of our globe, the sky assumes "a dark and awful appearance," the sun looking like "a hole of fire" in the blackness of space.

I must plead guilty to a slight inaccuracy of expression touching the admission of a beam of light into a darkened room. Of course, it is the light *reflected* from the particles of dust which becomes visible. What I meant to convey was, that were there no solid particles in the room—in short, were the light admitted into a vacuum, such light would be invisible.

If "Readingensis" would construct a "tenebroscope" (which he might easily do from the Abbé Moignos' description), he could at once make this abundantly clear to his own satisfaction. As regards "An Enquirer": I, of course, never intended to assert that the moon and earth were travelling together like two parallel trains—an image I only used to illustrate the fallacy of employing anything but a fixed external body as a point of reference to decompose a *compound* motion into its component parts. The remainder of "Enquirer's" letter merely consists in the reiteration of the assertion that the moon does not rotate upon her axis—*because she does not*; which peculiarly feminine style of argument must be taken "*quantum valeat.*"

I am, Sir, your most obedient servant,

May 7th, 1864. RURICOLA.

THE MOON CONTROVERSY.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—The controversy on the moon's rotation is, as acknowledged by many of your correspondents, a question of the meaning of that word. It seems that the difference arises from some referring the motion (rotation) to the centre of the moon's monthly orbit, the earth, instead of to the centre of its annual orbit, the sun. I send you two diagrams, one of which, laid down to scale, shows the track of the moon during one lunation, from which it will be perceived that the annual course of the moon round the sun differs little from a circle, being in fact an undulating curve, alternating in each lunation one 380th of the earth's orbital radius on the inside and outside of the earth's orbit. The second diagram shows the moon in nine different phases during one lunation from new to new; and supposing our satellite to have an arrow fixed through it on the plane of the equator at right angles to her axis—now it will be seen that the arrow-head gradually turns from the sun until the full, when it points in the opposite direction, and still continuing to turn, again points to the sun at the next new. From this it is evident that the moon has turned once round on her axis in that period, and, consequently, over twelve times in her annual revolution. If this is not rotation, what is? It cannot possibly be denied that the earth, performing the same thing in 24 hours, has rotated; then why the moon? Because she takes $29\frac{1}{4}$ days to do it in? *

If she did not rotate on her axis, we should not be, as we now are, in ignorance of the other half of her geography, as when she was inside the earth's orbit we should see one side, and when she was on the outside we should see the other; but a lunarian, whose residence unfortunately was turned from the sun, would be condemned to a perpetual night, 14 of our days illuminated only by the stars, and an alternate 14 by the stars and by his moon, the earth, in her varying phases from first quarter to third quarter. His antipodean on the sun side would have a perpetually unclouded sky, with a never-setting sun, and would see the earth in her phases from third

* We regret that we cannot present these drawings to our readers, owing to their size, but may state that they fully explain S. B.'s meaning.

quarter, new, to first quarter. This can be demonstrated by diagram, but is so self-evident as not to need it.

I remain, Sir, yours truly,

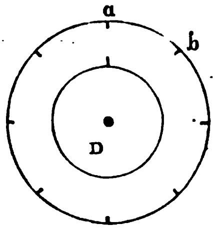
Manchester: May 5th, 1864. S. B.

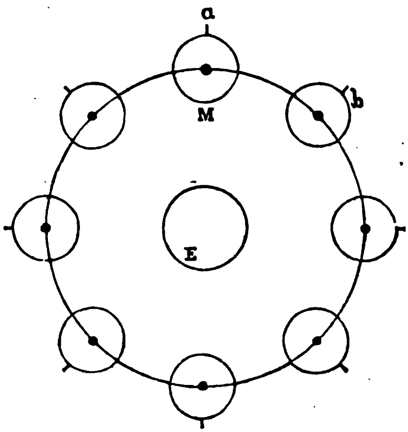
P.S.—Does not this controversy show the necessity for the formation of amateur societies in the principal towns, so that questions of this nature could be settled by discussion under the guidance of an advanced member? the societies at present in existence not being sufficiently open to amateurs.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—Will you permit me to offer the following proof that the moon rotates on her axis? I accept the definition of an opponent of the doctrine—"An Engineer," who in this month's *Register* says, "Rotation is a turning round, like a top, on a centre *within* the body." A study of the following diagram will, I think, convince any unprejudiced person that this is exactly what the moon does: she "turns, like a top, around a centre *within* the body."

I presume it will be allowed—1st, that a progressive motion of the rotating body does not vitiate its rotation. A boy's top, when whipped, has a progressive motion, and rotates at the same time. A cart-wheel rotates at the same time it progresses.—2nd, it cannot be asserted, either that the rate of *speed* in any way affects the *fact of rotation.* If a wheel actually rotates on its axis, it matters not whether it completes a thousand rotations in a minute, or one rotation in a thousand minutes—whether it rotates on its axis 28 times in 28 days, or only once in 28 days. Keeping these considerations in mind, I ask for a few minutes' careful study of the two following figures.





Let *D* represent a disc of any kind—a coin, a horizontal section of a top, or a section of the moon parallel to its equator, rotating around a *stationary* axis. If, in consequence of its slow rate of motion, the fact of its rotation

were denied, it would be proved by its *indicator* pointing first to *a*, next to *b*, and so on to the other points on the outer circle in regular and perpetual succession. Now let *D* be transferred to *M*, and represent the said lunar section, still rotating "around a centre within the body," but, instead of being stationary, having a progressive motion around the earth, *E*. If any-one should again deny its rotation, the same proof as in the other case establishes the fact. As we see the indicator exactly fulfilling the *same conditions*, we know that in making one revolution it has made one rotation, during which every part of the body has, in the words of "An Engineer," "turned around the centre within the body." If, instead of making only one rotation during one revolution, *M* made 500, no one would deny the fact of its rotation. But we have already seen that neither progress in rotating nor a slow rate of rotation in the least vitiates the fact of rotation, nor, in fact, has anything at all to do with it. I humbly think that any of your readers who are open to conviction, on looking a moment or two at the diagram will be convinced that it is impossible for *M* to move from *a* to *b*, at the same time changing the direction of its indicator, without, in the words of "An Engineer," the whole disc "turning like a top around a centre within the body."

I remain, Sir, yours respectfully,

Manchester: May 9th, 1864. J. T. SLUGG.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—In rotation on an axis, is it not necessary—

1st, That the axis shall be within the body rotating;

2nd, That one side of the rotating body shall travel in an opposite direction to that of the other side;

3rd, That all objects at a distance shall appear to be travelling in opposite directions to that of the direction in which the outside of the rotating body travels?

If some competent authority will give a categorical answer—yes or no—to these questions, we may take the case of the moon into consideration, with some probability of settling the matter.

Obediently yours,

May 11th, 1864. QUERY.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—Accepting the definition of revolving motion given by "An Engineer" and my friend Mr. E. Hopkins—namely, "progressive motion *in a circle*"—I beg leave to remind these gentlemen, that unless they regard the earth as at rest, the only progressive motion *really* described by the moon "in a circle" is *a circle round the sun*. Such a circle she describes every year, turning thirteen times upon her axis in doing so, just as truly as the earth turns 365 times in describing its orbit; which, if drawn to scale, say of an inch to a million of miles, would never diverge by a quarter of an inch from the circular path of the moon. That "An Enquirer," dating from *Cambridge*, should appear not to be aware of this fact, and call it my "theory," is certainly astounding! Let him draw a diagram to scale for himself, and I am sure he must give in his adherence to all that

I wrote as "J. R." He will not, I trust, suffer himself to be deceived by the so-called "physical connection" of "H.," or the "connecting rods" and "roulette table" of our Engineers and "Ruricola." The moon's body is detached from that of the earth; and as she makes each revolution on her axis, the earth turns also some twenty-eight times round upon itself, while both have, so far, progressed, *not* "in a circle," but merly in an "open arch," very slightly curved, being only an arc of one-thirteenth part of their interlaced circular orbit round the sun.—I am, Sir,

Your faithful servant,

J. REDDIE.

Hammersmith: May 14, 1864.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—As one of those who hail with pleasure each number of your interesting *Register*, I venture to ask the favour of your medium to address a few lines to "the Man in the Man." If he will kindly give me his attention for a few minutes, I cannot help thinking he may be induced to attribute the necessity of the long journey his cousin takes from the opposite side of the moon, in order to get a peep at us, to the *rotation*—the *slow* rotation, and not the *non*-rotation of the singular orb on which he dwells.

Bearing in mind that an axis is "an imaginary line upon which a body is supposed to rotate," it follows that the axis itself never rotates. It may *revolve*, of course, in whatever orbit that body makes round another object, inasmuch as it is a part of that body, but remains itself in the same direction as regards north and south.

Now, 1st, let us see what the effect would be if a body made a revolution round another body *without* rotating on its axis. To illustrate this more clearly, take a stick about a foot long, shave the sides till it is square instead of round, and mark one side *north*. Point one end, and thrust it through an apple. Then carry it round a circular table, taking care that the *north* side of the stick shall always face the *north* side of the room. It will be seen that the consequence of this revolution *without* rotation will be, that *every side* of the apple has in turn been presented to the table; and this, we all know, is precisely the reverse of what happens to the moon in her revolution round the earth. If "the Man in the Moon" has kindly followed me in this simple experiment, I cannot but think that he will agree with me, that if the moon were rigid on her axis during her revolutions, as he imagines, he and his cousin on their opposite sides of the moon would each in turn be gratified by looking at our earth, while we should rejoice to see what the other half of his world was like.

2ndly, let the apple now make another revolution, this time constraining it to keep its rosy side turned towards the table the whole way round it, at the same time taking care that the *north* side of the stick continues to face the *north* side of the room. Before we are able to do so, however, we must release the apple from its non-rotary condition, by enlarging the hole sufficiently to allow of its rotating round the stick. If, on starting, a mark be made on the same side of the stick as is the rosy side of the apple, when half the revolution round the table has been made, the rosy side will have travelled to the opposite side of the stick to that which is marked; and when the revolution is completed, the rosy side will have returned to the marked side of the stick, proving that it has made *one* rotation during the revolution.

"The Man in the Moon" says, "We have had many a laugh at the clever people on the earth who will insist that we rotate on an axis in the same manner as that body." We do insist that the moon and the earth both rotate on their axes, but with this essential difference—that the earth rotates 365 times during one revolution, and the moon rotates *only once* during one revolution; and I would humbly suggest that to *this fact alone* can be attributed the phenomenon of the same side of the moon being always turned towards the earth.

The interest I feel in the Moon controversy must be my apology for troubling you with this long letter.—I am, Sir,

YOUR CONSTANT READER.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—Is it not the case, that the notion held by common-sense practical people about the moon's movements is totally distinct from that propounded by mathematicians and astronomers? And would it not be better, as these learned men say that none but mathematicians can understand the question, to give up the dispute about the moon and occupy your columns with something of a less controversial character? Mathematicians confidently assert that every particle on the surface of the earth—every building, blade of grass, grain of sand—is rotating on its own axis! If this is their view, we may at once stop the discussion; but it is scarcely the view generally adopted of rotation. Ordinary people cannot conceive two bodies rotating together in the same direction side by side, each on its own axis, and yet at the same time firmly joined together! In the simple illustration of a carriage travelling round the earth, it surely cannot be denied by reasonable people that the wheels rotate on their axes: put on the drag, is not the rotation stopped? "Oh dear, no," say the mathematicians; "it still rotates; *because* when you have got quite round the world with the drag on, an outside spectator will have seen all round the wheel!" When, then, does it not rotate? "Why," say the mathematicians, "it *does not* rotate when it *does* rotate backwards once in its revolution round the earth!" If we assign to the moon an axis on which it either does or does not rotate (such axis, in fact, having no existence), we must, if we wish to be consistent, allow the same effects to occur as would be produced by the actual existence of such an axis.

As the axis of the carriage-wheel would travel in its path round the earth presenting one side foremost in its path, so does the supposed axis of the moon travel round the earth presenting one side foremost. And in regard to rotating on this axis, the wheel and the moon are in the same condition: when the drag is put on, the rotation of the wheel is stopped; and the attraction of the earth acts as a drag to the moon, by which its rotation also is stopped. It is universally admitted, that one of the strongest proofs of rotation is the oblate spheroidal shape of bodies which are endued with this particular motion. The sun, the earth, the planets, are all rotating, or spinning, and all are more or less of this shape. But no such flattening is discovered in the moon: on the contrary, it has been often stated that the moon projects towards the earth on that side which is turned towards us, which would seem to be an effectual bar to its rotation on its axis.

I am, Sir, obediently yours,

May 20th, 1864. D. Y. C.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—The analysis on which your correspondent "Analyst" depends to prove his argument is so full of blunders, that I hardly know where to begin in offering a few remarks on the subject of his letter. His mathematical symbols, however, look so imposing, that it seems the more necessary to expose their fallacy, lest the unwary be deceived.

If he will refer to the diagram he used in working the problem, he will see that he has begged the question; and it is this fact which causes his analysis, though erroneous, to give some semblance of a proof. Thus,

If the needle NS is always parallel to itself, then the angle it makes with any fixed line, as the axis of x, is always the same. This angle he has assumed to be made up of *two components*, viz. λ and ϕ, of which the latter varies with the position of A. This assumption being allowed, no proof is necessary. If we assume two components, we assume the whole point at issue; but that is just the thing which we must not do.

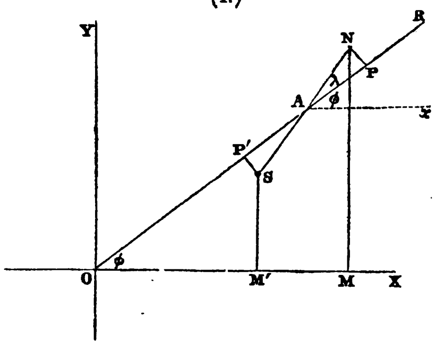
The fact is, that analysis, without some such undue assumption, can throw no light on the subject at all, at least in the way which your correspondent has attempted.

I remain, Sir, your obedient Servant,

Alton, Hants: April 1864. ALFRED W. DEEY.

P.S.—The accompanying diagrams will serve to exhibit the technical blunders which "Analyst" has made.

(I.)



Does (I.) represent the diagram which 'Analyst' has used?—if so, his results are erroneous. Thus, OA $= a$; AN $= e$; NAB $=\lambda$; BA$x =$ AO$x = \phi$. Then (he says) the equations $x_{,}= e\cos\lambda$, $y_{,} = e\sin\lambda$, and $x_{,,} = e'\cos\lambda$, $y_{,,} = e'\sin\lambda$, express the oscillations of the needle-points N. and S. ($x_{,}$ and $y_{,}$ are here the co-ordinates of N; A being the origin, and AB the axis, of x).

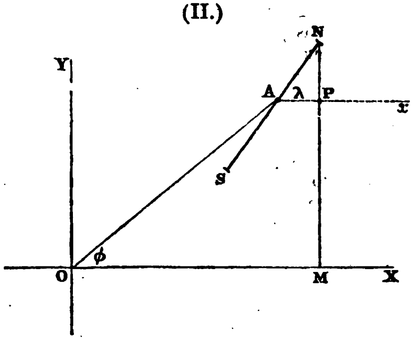
(He continues) The orbit of A round the apple (o) is expressed by the equations, $x = a\cos\phi$; $y = a\sin\phi$; and the equations of the curves in space, described by the needle-points, are, $x_{,} = a\cos\phi + e\cos(\phi+\lambda)$; $y_{,} = a\sin\phi + e\sin(\phi+\lambda)$: and $x_{,,} = a\cos\phi + e'\cos(\phi+\lambda)$; $y_{,,} = a\sin\phi + e'\sin(\phi+\lambda)$.

Here $x_{,}$ and $y_{,}$ are OM and MN respectively; and $x_{,,}$ and $y_{,,}$ are OM′ and M′S . . . which, it will be observed, are quite different values from those he assigned them above; and yet he proceeds to say that $y_{,} = y_{,,}$: which statement is only true on the original supposition, viz.—that $y_{,}$ is NP, and $y_{,,}$ is SP′.

What confusion we have here!

But, apart from the consideration of minor mistakes, the whole is based upon an undue assumption. The only correct equations are deduced from the annexed

(II.)



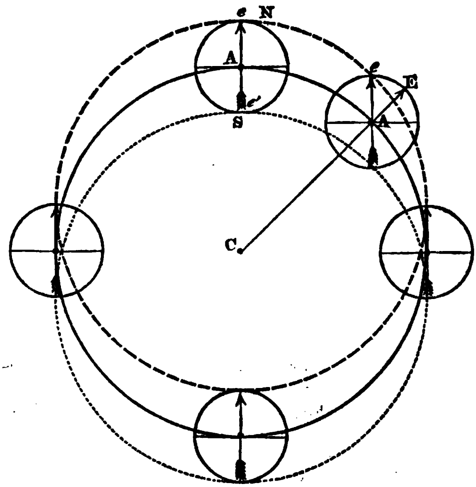
(Fig. II.), in which NAx is λ: to divide this into *two* component $\angle$s is to beg the whole question.

Let OM = X, and MN = Y, and $e' = -e$:
Then, as before, $x_{\prime} = e \cos \lambda$; $y_{\prime} = e \sin \lambda$; and $x_{\prime\prime} = -e \cos \lambda$; $y_{\prime\prime} = -e \sin \lambda$. Then the equations of the curves in space, described by the needle-points, are simply these:

$$X = a \cos \phi;\ \pm e \cos \lambda:$$
and $Y = a \sin \phi;\ \pm e \sin \lambda.$
From which, as I said before, nothing can be proved.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—Although most unwilling to trouble you with another letter upon a subject which, no doubt, most of your readers are already tired of, I cannot allow the letter of "Analyst" to pass unanswered, inasmuch as it may puzzle some who, like myself are not sufficiently proficient in mathematics to follow his reasoning. But although unable to do so, I cannot *therefore* accept the conclusion at which he arrives, because it is so palpably opposed to plain fact capable of ocular demonstration. If a body always turns a given side in the same direction, obviously it *cannot* rotate: how, then, *can* analysis prove that it *does?*



Path of Axis A.
" North Point of Needle.
" South Point of do.

Not being competent myself to follow "Analyst" upon his own ground, or to analyse his process, I took the liberty of placing my difficulty before Professor De Morgan, and I am indebted to his courtesy for the following remarks upon it:—"Your critic is not clear in his account of his own process. But, on the only interpretation I can give him which makes him consistent with himself, he assumes the whole point in the plainest way. He virtually lays down that $\lambda = o$ means that e does not rotate—that is, (see diagram,) that AE is Ae without rotation. Grant

him this, and it follows, without any algebra, that Ae rotates in keeping its parallelism. But to grant him this is just to give up what appears to me, as to you, an obvious result of common sense."

The Professor concludes his letter to me by expressing his surprise that any one can be found seriously to answer the notion that a line which preserves one direction can revolve, rotate, or do anything *round* a point in it. If the compass box were fastened to a revolving radius, it (the box) would then rotate once during one revolution; but the compass-card—always preserving one direction—would *not* do so, though in that case the point *would* turn under the centre A. I leave it to the sense of your readers whether there is any casuistry or not in this statement, which appears to have been anticipated by "Analyst."

I am, Sir, obediently yours,

A. L. S.

Knightsbridge, S.W.: April 18, 1864.

THE SCIENTIFIC RECORD.—We regret that this periodical, which might have been rendered exceedingly useful and popular, has ceased after publishing two numbers only. The list of contributors included some excellent names, and the numbers published contained much interesting matter.

THE METEOROLOGICAL MAGAZINE is the title of a new monthly devoted to this science, which has just been started. The publishers are Williams and Strahan, Lawrence Lane, E.C.

THE ASTRONOMER ROYAL AT CAMBRIDGE.—The Astronomer Royal delivered Sir Robert Rede's lecture in the Senate House, Cambridge, on May 10, choosing for his subject "The late Observations of Total Eclipses of the Sun, and the inferences from them." The audience was not large, but was, so far as the male portion of it was concerned, of an almost strictly scientific character. A number of ladies graced the Senate House with their presence. In the galleries about 200 undergraduates assembled, and who, when the Astronomer Royal had exhausted the more direct matter of his subject, applauded him to the echo in his concluding observations. The Astronomer Royal pointedly observed that he thought it desirable that gentlemen who went out as fourth and fifth wranglers should know that one end of a magnet was not always equivalent in power to the other end. He thought that more mathematical physics or more physical mathematics might be introduced into the University course with advantage. Entertaining these views, he felt great pleasure in standing there to support Sir Robert Rede's institution.—*Standard.*

ANOTHER EARTHQUAKE IN ENGLAND.—On the 30th of April last, a smart shock of an earthquake was felt in several parts of Sussex, the first account of which was given by Captain Noble, of Maresfield, in a letter to the *Times*. He says:—"At 11 h. 9 m. G.M.T., an extraordinary vibration, lasting some 15 seconds, was felt, shaking the doors, &c. in the house with some violence—several persons leaving their beds in alarm. . . . This was followed some time afterwards by a rushing sound, as of violent hail against the windows; but on looking out nothing was visible, nor had there been any storm of the kind." The shock was felt in the adjoining parishes, and also in the town of Lewes, twelve miles distant. At Sheffield Park, the shutter bars oscillated; at Scaymes Hill, the bells vibrated; and at Fletching, rumbling noises were heard. A lady in the town of Lewes distinctly heard the rushing sound of hail against the windows some time after the shock.

ASTRONOMICAL OCCURRENCES FOR JUNE 1864.

DATE.		h. m.	Principal Occurrences.	Jupiter's Satellites.	h. m. s.	Meridian Passage. h. m. Jupiter.
Wed	1	 10 30	Sidereal Time at Mean Noon, 4 40 53·1 Conjunction of Venus and Mercury, 2° 56′ S.	1st Ec. R.	10 31 13	10 30·2
Thur	2	19 28 23 7	Conjunction of Moon and Mercury, 2° 59′ S. Conjunction of Moon and Venus, 0° 21′ N.			10 25·8
Fri	3	23 40	● New Moon			10 21·4
Sat	4	19 14	Conjunction of Moon and Uranus, 3° 14′ N.	2nd Oc. D.	11 43	10 17·1
Sun	5			3rd Oc. D.	13 25	10 12·7
Mon	6			2nd Tr. E. " Sh. E.	9 3 10 13	10 8·4
Tues	7			1st Tr. I. " Sh. I. " Tr. E.	12 20 12 56 14 32	10 4·0
Wed	8	10 29	Near approach of Moon to A² Cancri (6)	1st Oc. D. " Ec. R.	9 39 12 25 35	9 59·7
Thur	9			1st Tr. E. " Sh. E.	8 58 9 37	Moon. — 4 2·6
Fri	10					4 45·3
Sat	11	10 38 23 48	Occultation disappearance of p^2 Leonis (6) ☽ Moon's First Quarter	2nd Oc. D.	14 1	5 27·3
Sun	12					6 9·3
Mon	13	19 20	Conjunction of Moon and Saturn, 5° 59′ N.	2nd Tr. I. " Sh. I. " Tr. E. " Sh. E.	9 2 10 27 11 20 12 48	6 52·1
Tues	14	13 37	Near approach of Moon to ι Virginis (5)	1st Tr. I.	14 6	7 36·7
Wed	15	18 0	Conjunction of Uranus with the Sun	1st Oc. D.	11 25	8 23·9
Thur	16	 1 25 14 6	Sidereal Time at Mean Noon, 5 40 1·5 Conjunction of Mercury and δ^1 Tauri, 8m·1 E. Conjunction of Moon and Jupiter, 1° 0′ N.	3rd Tr. E. 1st Tr. I. " Sh. I. 3rd Sh. I. 1st Tr. E. " Sh. E. 3rd Sh. E	8 22 8 33 9 19 9 23 10 45 11 31 11 33	9 14·3

DATE.		h. m.	Principal Occurrences.	Jupiter's Satellites.	h. m. s.	Meridian Passage. h. m.
						Moon
Fri	17	12 27 13 34 13 20 15 13	Occultation of ω^1 Scorpii (4½) Reappearance of ditto Near approach of Moon to ω^2 Scorpii (4½) Greatest Westerly Elongation of Mercury, 22° 35′	1st Ec. R.	8 48 42	10 8·1
Sat	18	12 23 13 21	Occultation of B.A.C. 5788 (6) Reappearance of ditto			11 5·1
Sun	19	10 19 10 54 15 54 16 10	Near approach of Moon to B.A.C. 6098 (6) ○ Full Moon Near approach of Moon to μ^1 Sagittarii (4) Occultation disappearance of 15 Sagittarii (5)			12 4·1
						Jupiter.
Mon	20	17 6	Near approach of Moon to *d* Sagittarii (5)	2nd Tr. I. " Sh. I. " Tr. E.	11 20 13 2 13 40	9 8·4
Tues	21	6 3	Conjunction of Mercury and ε Tauri, 7m·6 W.			9 4·2
Wed	22			2nd Ec. R. 1st Oc. D.	9 34 53 13 12	9 0·0
Thur	23	8 0	Conjunction of Uranus and Venus, 0° 8′ S.	3rd Tr. I. 1st Tr. I. " Sh. I. 3rd Tr. E. 1st Tr. E. 3rd Sh. I. 1st Sh. E.	9 49 10 21 11 14 11 52 12 32 13 22 13 26	8 55·8
Fri	24			1st Ec. R.	10 43 14	8 51·6
Sat	25					8 47·5
Sun	26	2 15 11 13 13 23 14 11 13 40 14 40	☾ Moon's Last Quarter Conjunction of Moon and Mars, 4° 16′ S. Occultation of 62 Piscium (6) Reappearance of ditto Occultation of δ Piscium (4½) Reappearance of ditto			8 43·3
Mon	27					8 39·2
Tues	28					8 35·0
Wed	29			2nd Ec. R.	12 11 41	8 30·9
Thur	30	14 26 15 14 15 59	Occultation reappearance of B.A.C. 1361 (6) Occultation of ε Tauri (3½) Reappearance of ditto	1st Tr. I.	12 9	8 26·8

THE PLANETS FOR JUNE.

Mercury continues in the constellation Taurus throughout the month, rising about half-past three on the 1st and about twenty minutes to three on the 30th of June. About the middle of the month it may be observed as a morning star.

1st. R.A.	3 47 47	Decl. N. 16 16	Diameter 11″·4
30th. „	5 20 57	„ 21 57	„ 6″·0

Venus passes from Taurus into Gemini during the month, but is badly placed for observation, rising about a quarter past three o'clock.

1st. R.A.	3 45 16	Decl. N. 18 59	Diameter 9″.8
30th. „	6 17 2	„ 23 40½	„ 9″·6

Illuminated portion of the disc of Venus—0·988.

Mars rises about half-past one in the morning at the beginning of June, and shortly after midnight at the end of the month, and may now be observed after those times. It is in the constellation Pisces.

1st. R.A.	0 15 25	Decl. S. 0 19½	Diameter 6″·4
30th. „	1 32 43	„ N. 7 37½	„ 7″·2

Illuminated portion of the disc of Mars—0·859.

Jupiter continues in the constellation Libra, and is well visible throughout the night, being a conspicuous object, although low in the south.

1st. R.A.	15 13 0	Decl. S. 16 46	Diameter 41″·8
30th. „	15 3 28	„ 16 14	„ 39″·6

Saturn is getting away to the west, but may still be well seen, setting at two o'clock in the morning at the beginning, and about midnight at the end of the month. It continues in the constellation Virgo.

1st. R.A.	12 46 10	Decl. S. 2 6½	Diameter 16″·6
30th. „	12 46 25	„ 2 16	„ 15″·8

Dimensions of Ring—Outer major axis, 40″. Outer minor axis, 6″.

THE MINOR PLANETS.

The following are the Minor Planets which will be on, or within one hour of Right Ascension on either side of, the Meridian, between nine and twelve o'clock during the evenings of June. Their places are to be found in the Supplement to the *Nautical Almanac* for 1867.

	Magnitude.		Magnitude.
Juno...	9·7	Thetis	9·3
Astræa	10·8	Bellona	10·5
Victoria	8·5	Circe	11·7
Eumonia	9·5	Erato	12·5

Unusual Heat of the Weather in May.—From the 15th to the 20th of May the thermometer has ranged as high as 84° in the shade—so high a maximum not having occurred for many years. In a letter dated the 19th, Mr. Dawes says:—"Think of the thermometer, in deep shade, on the north wall of my observatory, indicating 84°·4 of Fahrenheit on May 17! It rose to 81°·6 on the 16th, and to 83°·0 yesterday." This great heat was followed by a heavy thunderstorm, which took place about eleven o'clock on the night of the 20th.

Mr. De La Rue's Soirée.—We anticipate a great treat for those who have tickets for Willis's Rooms for the 11th of June. As this is, we believe, the first occasion on which a soirée has been given to the Fellows of the Royal Astronomical Society and their friends, it is likely to present features of the greatest interest. We trust that too much room will not be taken up by the opticians with instruments, which may at any time be seen at their own establishments, but that ample space will be given for a series of illustrations of the progress of Astronomy, both in theory and practice, by the exhibition of the older and more curious as well as of the beautiful modern appliances, so as to show the great advance made in all departments of this most interesting science. Astronomers, both public and private, have reason to feel greatly indebted to the President for the opportunity thus given.

The First Principles of Natural Philosophy.—A handy little work, by Mr. W. T. Lynn, of the Greenwich Observatory, has recently been published by Mr. Van Voorst, of Paternoster Row, in which the fundamental principles are well and concisely explained. Mechanics, Statics, Dynamics, Hydrostatics, &c. are illustrated by description and diagram, and, of course, Optics and the principles of the telescope and microscope are not omitted; and we may add that the mathematical reasoning employed is kept within strict limits. On the whole, it is a useful work, and not too large to put into the pocket.

TO CORRESPONDENTS.

Owing to the great length of our Reports and Correspondence, our usual Tables of Nebulæ, &c. are unavoidably deferred until next month.

The following communications are also postponed:—"B.," "H.," "Phœbus," "Obscurus Homo," "Gamma," and some others.

In answer to many enquiries, we may state that the Title-page and Index to Vol. I. are now ready, and will be forwarded to those subscribers who have taken the *Register* from the commencement. A few bound copies of the volume may be had on application to the Editor, price 12*s.* each.

In deference to an expressed wish, the *Register* will in future be forwarded from the Editor in covers of a different colour to the wrappers.

Astronomical Register.—Subscriptions received for 1864.

The Editor's List.

To June.—Brodie, F.; Howard, Rev. G. B.; Jefferies, J.; Jones, W. E.; Jones, W. C.; Lancaster, W. L.
To December.—Shuter, J. L.

Errata.—In the letter of "An Amateur," p. 119, last number, 5th line, for true *cone* of the sphere, read true *curve* of the sphere. Last line but one, for *line* of rotation, read *time* of rotation.

CONTENTS.

The Astronomical Register.

No. 19. JULY. 1864.

ROYAL ASTRONOMICAL SOCIETY—THE PRESIDENT'S SOIRÉE.

In our last number we stated that the fortunate holders of tickets for Willis's Rooms on the 14th of June would have a great treat, and the event of that evening proved that our anticipations were not unfounded. An assemblage of upwards of five hundred scientific celebrities, a collection of the most interesting objects, not entirely confined in their relation to Astronomy, excellent and well-lighted rooms, and last, but certainly not least, a sumptuous supper, to which full justice was done,—he must be hard to satisfy indeed who did not bring away with him a pleasing recollection of the President's *soirée*. Where so much calls for notice, it is almost impossible to escape appearing invidious in pointing out the principal objects of attraction; but as in all exhibitions of the kind some things were eminently conspicuous, we will endeavour to specify a few of those which attracted attention in the strongest manner. And in the first place, the fine exhibition of lunar photographs by Mr. De la Rue himself was conspicuous; his Eclipse photographs, and also some of the solar spots; and the series of discs of the sun, contributed by Professor Selwyn. Of diagrams there was a fine display: Mr. Nasmyth's wonderful representations of the surface of the moon; spectra of the stars, by Dr. Miller and Mr.

Huggins; also diagrams and drawings by the Astronomer Royal, Lord Rosse, Professor Phillips, Mr. T. W. Burr, &c. &c. Foremost in display of instruments were Messrs. T. Cooke and Sons, whose equatorial mountings, combining solidity with elegance, are so universally admired. Colonel Strange's new zenith sector, though unfinished, excited attention from its novel arrangements; and a fine object-glass of 10 inches diameter, and only 10 feet focus, by Merz, was looked at with longing. M. Redier, from Paris, exhibited and explained his apparatus for taking transits mechanically; and M. De la Rue showed his new diagonal unsilvered reflector for observing the sun, so constructed as to do away with the second reflection. Mr. Charles Frodsham had a fine display of chronometers, clocks, and watches, including a turret-clock, an astronomical clock with galvanic apparatus, and an endless variety of pocket-watches for timing, observing, and other purposes. With regard to the history of Astronomy, there were to be seen the telescopes of Huyghens with single object-glasses, and other old telescopes of still greater antiquity, some of preposterous length in proportion to their aperture, the latter contributed by Mr. Williams; also quadrants of extraordinary construction, and instruments unintelligible almost to observers of the present day. We must not omit to mention that our indefatigable friend Mr. Perigal exhibited a variety of apparatus to show the movements of the moon; and if we may judge by the crowd which gathered round his table, the subject excited considerable attention. On the whole, if any fault is to be found in regard to the display of objects, it rests with those who did not avail themselves of the noble opportunity afforded to them by Mr. De la Rue; and as we have heard many exclaim, "Oh, if we had but thought of it, we would have sent such and such a thing," we can only say, let them be better prepared in future, in case such another opportunity should ever occur. Nevertheless, the meeting was of so important a character, and the collection so interesting, that we may recur to the subject in a future number.

Double Stars.—In the *Astronomische Nachrichten* for May 28, will be found a valuable series of double-star measures, by Baron Dembowski, of Gallarate. Nearly 200 stars are treated of.

ROYAL ASTRONOMICAL SOCIETY.

Eighth Meeting, June 10th, 1864.

John Lee, Esq., LL.D., F.R.S., *Vice-President*, in the Chair.

Secretaries, Rev. C. Pritchard and Mr. Hodgson.

Among the usual presents, a work of Colonel Walker on the *Survey of India* was particularly noticed.

S. Player, Esq.,

was balloted for, and duly elected a Fellow of the Society.

On the Star β Leonis, by G. Knott, Esq.—Three stars were originally figured in this group by Admiral Smyth, but Mr. Knott finds it to differ both in description and diagram; the angle of B requiring to be increased 90°. Curiously enough, there is a minute star near the place assigned to B in the cycle, of the 11·7 magnitude.

On the Star ν Herculis, by the Rev. W. R. Dawes.—The small star S. P. is binary, having moved to the extent of about 18° in the last five or six years; it somewhat resembles μ Bootis. Three sets of measures in 1859 give a mean of $P=59° \; D=2''\cdot 0$; while at present it is found to give $P=77° \; D=1''\cdot 8$. Mr. Dawes had also observed Antares on the 6th of June, but found no change in the position of the small star.

A letter from Prof. Bond referring to the statements made in the Annual Report of the Society, on the authority of Messrs. Stone and Carpenter, that by comparison of an engraving from Prof. Bond's drawing with the nebula, during last winter, they had come to the conclusion that Sir J. Herschel's drawing represented the subject better than Prof. Bond's, and especially that the outline of the *jaws* was too hard and massive, and the space between them too black. Prof. Bond said that the engraving referred to was only a proof of an unfinished engraving, and he suggested that the difference between his drawing and Sir J. Herschel's was more in regard to relative intensity of light than in outline, and that as he found the space between the jaws had really much more light than Herschel's, there being barely one-

sixth part not luminous, he thought the Greenwich observers had perhaps compared the engraving only by night, and not by daylight, when the faint luminosity would have been seen.

Mr. Stone said that the nebula had been carefully observed, at the suggestion of M. Otto Struve, who thought there was evidence of change in its form; and Mr. Carpenter having been entrusted with the observations, had appealed to him, and he considered Mr. C. correct in thinking the squareness of outline in Prof. Bond's drawing exaggerated, and that Sir J. Herschel's represented the object better, thus tending to show that the nebula remained as when seen by Sir J. H. at the Cape. The importance of the subject justified drawing attention to it, and he hoped other observers would take the next opportunity of comparing the drawings with the object.

Mr. Pritchard: Are you speaking of drawings or engravings? because if the latter, we find it impossible to get engravers to do justice to drawings. Allowing for this difficulty of engraving, it is probable Professor Bond's representation is very right.

Mr. Hodgson: We have got the American and the English drawings; but I should like to see with them the Russian drawing and exhaustive paper of Lippenhoff.

Mr. Stone: It should not be overlooked that with regard to change in the nebula, our strong feeling of the accuracy of Herschel's drawing indicates no change. As to the Russian drawing, Dr. Winnecke, who is here, can perhaps tell us something.

Dr. Winnecke: In the drawing referred to, the stars are laid down with extreme accuracy; but I don't think it can be relied on for exact detail of light and shade.

Mr. Lockyer remarked that the Rev. Mr. Webb, who had looked much at the nebula last winter, agreed with Messrs. Stone and Carpenter.

Mr. Pritchard again adverted to the difficulty of engraving drawings of such objects.

Mr. Vignoles: Photograph them.

Mr. Hodgson: It won't do.

Mr. Vignoles: It will. Excuse me, but I am in the habit of having maps and drawings constantly photographed with the best result, and the Government do so extensively, reducing plans most perfectly.

Mr. Hodgson: I suppose engineers say photographs are sufficient for all practical purposes.

Mr. Vignoles: Absolute correctness is required, and is obtained.

Mr. Hodgson: The difficulty is in the shading.

Mr. Beck: Photographs can be taken so perfectly from pencil drawings as not to be distinguished from the original.

Mr. Hodgson: Will you reproduce a drawing of a nebula we have received from Mr. Lassell, and which we are afraid cannot be done justice to?

Mr. Beck: I have no doubt I can, but must see it first.

Mr. Pritchard: Will any patriotic member do this; that is, reproduce Mr. Lassell's drawing like the original? If so, we will gladly pay him; or he may do it without, if he likes. Mr. Lassell, in his zeal for the cause of astronomy, has built a magnificent telescope, has expatriated himself as it were, and we are bound to carry out his wish of reproducing his drawings properly, if possible.

Mr. Vignoles: Two to one on Mr. Beck.

A letter from Mr. Lassell, dated Malta, 28th May, accompanying the drawing of the nebula 20 M. Sagittarii, was then read. It gave some interesting details of observations with the smaller 9-inch reflector, which is of extreme excellence in definition. On the 21st May, Mr. Lassell noticed irregularities on the moon's outline, such as related by Mr. Cooper Key in the Monthly Notices (see *Ast. Reg.* vol. i. p. 184), but they were not so great in extent nor in the same places. This telescope is so fine that the appearance cannot be optical. It shows the 6th star in the Trapezium of Orion, and Enceladus in the present appearance of Saturn. The small star near δ Cygni, which is a good test, was seen with power 421; μ Bootis separated with 722. The *comes* of Antares is so obvious as to be no test; γ Coronæ was round with all powers on this telescope; but this is not to be wondered at, as it required 1060 on the 4-foot reflector to show it. It is a rather unequal close double star. The small star near Procyon had been examined by Mr. Marth and Mr. Lassell, who did not consider its physical connection established; and observations of Uranus and Neptune had been made, but owing to the weather not being comparable to that of 1852, with no important result. Mr. Lassell was now occupied in drawing Saturn. He

was not satisfied with previous drawings of nebulæ, but had now got an Italian artist who, he thought, succeeded better, and the sketch of 20 M was a specimen. (Mr. Hodgson thought it was really 21 M.)

Admiral Manners said that with reference to the question of photography, he had a friend sitting by him who, he thought, could reproduce any drawing, and the gentleman alluded to expressed his willingness to try.

Mr. Hodgson: As to γ Coronæ, I should like to know whether other observers confirm its difficulty. Some years ago it was very evident to Mr. Dawes and myself with my 6-inch object-glass, and must have altered.

Dr. Winnecke: It is closing up.

On the Achromatic Object Glass, by Mr. Hodgson. The author wished to draw attention to the form of the arrangement in which English opticians still followed that of the elder Dollond, while foreign artists had made variations. He exhibited and explained diagrams of the forms and combinations used, including Dollond's, in 1758; the triple glass of the second Dollond, in 1765; that of Fraunhofer, in 1818, having one surface plane, and Sir J. Herschel's, which resembled it; Mr. Barlow's combination of 1827, and Steinheil's latest productions, founded on a formula of Gauss, in 1817, and which are commended by Mr. Bond. It seemed to Mr. H. that either Dollond's theory was perfect, or English opticians were lazy in not attempting improvement. In a paper by Littrow, it was stated that with 60 inches focus, 9 inches of aperture ought to be used; but every one knows this cannot be made by any optician. Sir J. Herschel gave the curves for a 4-inch aperture of 30 inches focal length, and Mr. Dollond made the glass, but it was useless and unsaleable; but Tulley made a good $3\frac{3}{4}$ of 45 inches. In 1849 Mr. Hodgson worked out Barlow's theory, and had a glass made which performed well on the 5th star in the Trapezium of Orion and other tests. This was only ground once and once polished.

Mr. Pritchard: Did you measure the refractive indices and the dispersive power of the glasses used, by having prisms made, and testing them?

Mr. Hodgson: No. There is no need to use prisms. I followed Barlow's method. The achromaticity was tested experimentally on the moon and Venus.

Mr. Pritchard : Let us look at this philosophically. If any man tells me he has got the refractive index and dispersing power by testing prisms, I know he can calculate the curves by Herschel's and Barlow's methods, and then with good glass and a good workman he may turn out a capital object-glass; but if this be not done the experiment is not worth "one tenth of half a rush."

Mr. Hodgson : Chance now makes glass so nearly alike from year to year, that it is not necessary to measure its refraction.

Mr. Simms : It varies as much as 10 per cent.

Mr. Hodgson : I believe the specific gravity does not vary, and the dispersion follows this. I wish philosophers and mathematicians would give us tables an ordinary workman could follow. The object-glass I had made is here. The calculated focus was 63 inches, and it is really 62¾.

Mr. Whitbread thought glass-casting could not be accomplished without striæ. His experience was to that effect.

Mr. Hodgson : I think Mr. Cooke has 2 discs of 25 inches, which he is working, and considers satisfactory. The manufacture of glass is progressing, and the introduction of Siemen's gas furnace is a great step in this direction.

Mr. Pritchard : About 10 years ago I went into this subject mathematically; and, while I admit very beautiful glasses have been made, I do not admit that they have been produced by rigid adherence to the calculated curves. It was supposed that the refractive indices and dispersive powers being found, the curves could be given (if the glasses are cemented this must be allowed for); and mathematicians give these curves, but the optician can't grind them. There is no doubt about this. I may give the the 4 radii and the distances of the lenses to a workman, but practically he can't get a sphere at all. He can only approximate to it, and neither Airy's, Herschel's, nor any other method can be carried out. Still we are surprised and gratified at the success which results. The theory is this: mathematicians calculate the minimum of aberration; and some try for no aberration at all, and get the same result. When a function is at its maximum or minimum, the variables may differ considerably. The workman goes by rule of thumb, and alters all the surfaces until he gets near perfection, preserving achromatism and nearly destroying aberration.

Mr. Hodgson : All that has been just said applies to photo-

graphic lenses, where the sitter is twelve or fifteen feet distant; but with parallel rays the difficulty vanishes. I want opticians to have the numbers given them for Chance's glass—not symbols, but plain figures. Mr. Pritchard omitted the question of aperture. Mr. Simms had a 15-inch glass once very near perfection, but trying again failed; and I now have it, and know how far off it is from being useful.

Mr. Pritchard: The question of aperture is not referred to in my colleague's paper.

Mr. Beck: We must not compare camera and opera-glass lenses with telescope work. The difficulty of the latter as compared with the former is extreme. When the curves are got by grinding, the polishing will throw them entirely out. Mr. Chance cannot yet insure good glass, but runs the risk of many failures and much cost.

Mr. Cayley: I should like to know whether the effect of errors has been worked out; that is, what error a certain deviation from the curves will produce.

Mr. Pritchard: Opticians can only work to about the tenth of an inch.

Mr. Dallmeyer: We can work readily to the 100th of an inch. Our process is to calculate the curves from the known refraction and dispersion of the glasses, but we do not use prisms for getting these. Barlow's method was to get the refractive index from the focal length of a lens, and the dispersive power by combining glasses. I use a table computed on Coddington's formula, and find it of the greatest service. Mr. Hodgson thinks it difficult to give the workmen the right curves, but the difficulty is to get a spherical surface and keep it. His glass is not properly polished, and this explains its success; finish it, and its figure is gone. In Dollond's glasses no correction is made for near or distant objects. Sir J. Herschel's theory will produce a coma in one direction, and Mr. Airy's a coma in the other; by taking a mean of the two, and combining the glass with the Huyghenian eye-piece, this aberration is corrected. I doubt that Gauss's formula allows greater aperture than others, as the chromatic aberration increases as the cube of the diameter, while the spherical aberration only as its square.

On Suspected Changes in the Lunar Surface, by the Rev. T. W. Webb. (See the article in the present number of the *Register*, page 159.)

Another paper *On the Bright Band on the Moon's Limb, in Eclipses of the Sun*, by the Astronomer Royal. The author adhered to his opinion that this effect was not due to anything of an atmospheric character. He had received photographs of the eclipse of 1860 from Professor Alexander, and found that the band appeared to vary with the distance from his eye, proving it to be due to nervous irritation of the retina from contrast.

Professor Selwyn exhibited and described one hundred and forty-four discs of the sun, taken by means of photography, with a telescope by Dollond, and photographic apparatus by Dallmeyer. He also showed a few larger discs, being some of the first taken by a telescope of greater size by Slater. Professor Selwyn also again referred to the vorticose movement of the spots, as mentioned at the meeting in January. (*Ast. Reg.* vol. ii. p. 32.)

Mr. Howlett also exhibited some drawings, on an extended scale, of the solar spots, and mentioned a curious phenomenon which he had observed in connection with one of them. "On the 25th of January, at 11 a.m., I began to draw this spot, and there was a patch of dark tint on the edge of the penumbra; when I had completed the drawing I found that this patch had moved away from the place where I had depicted it, and at a later period of the day it had moved still farther towards the centre of the spot."

Colonel Strange then described, with the aid of models and diagrams, a zenith sector for the great survey of India—an astronomical, but not an astronomer's instrument, a portion only of the circle being used. At first this sort of instrument was a telescope, with an arc at the extremity; but Mr. Airy took it in hand and produced the instrument so extensively used in the British survey. The Astronomer Royal's zenith sector, however, was too heavy for transporting across the mountains in India, and the modification now shown was adopted. A hollow cast-iron cone is employed, within which is the vertical axis; on this is a horizontal axis, with the telescope and sectors, which move together. The graduations on the sectors are read by means of four long converging microscopes, similar to the transit instrument at Greenwich, which are illuminated in the same manner. It is an instrument for determining latitude, or investigating local attraction.

Mr. De la Rue exhibited a glass reflecting prism, to be used instead of the small reflector of a large reflecting telescope, and principally adapted for viewing the sun.

Mr. C. Frodsham made a few remarks on the importance of mechanical accuracy in the instruments employed in observations.

Papers by Mr. Balfour Stuart on the *Large Sun Spot Period*, and by Mr. Williams on *Solar Eclipses*.

Captain Noble called attention to a letter in the *Astronomical Register*, by Mr. Hopkins, stating that the diameter of the sun was caused by our variable atmosphere, and was not the effect of variable distances; and that the sun, when measured in the zenith, at the tropics appears the same size all the year round (*Ast. Reg.* vol. ii. p. 133). As this extraordinary statement could be affirmed or disproved by the observations made at the Cape and at Greenwich on the same day, it might be worth while to compare these observations.

Mr. Hodgson said they would be most happy to receive a paper from Captain Noble on the subject at the November meeting.

After a few words from Mr. Brayley with reference to Professor Selwyn's remarks on the vorticose nature of the solar spots, the meeting was adjourned to the 11th of November.

ROYAL OBSERVATORY, GREENWICH.

The Annual Visitation of this celebrated establishment took place on the 4th of June, and as—a rather unusual occurrence for an astronomical appointment—the day was fine, the whole affair went off with success. While the Astronomer Royal and the Board of Visitors were engaged with the routine business connected with the Report, &c., the other visitors who were favoured with invitations availed themselves of the opportunity of minutely inspecting the instruments and apparatus for which the Observatory is so famous. We need scarcely say how well they were repaid for the trouble of climbing up narrow staircases, thrusting themselves through little doors and traps, or descending into pits: the marvellous accuracy of the instruments and the extraordinary order in which they are kept are too well known to require especial notice. With each instrument—the transit circle, the new great equatorial, the altazimuth, &c., was a Greenwich

Observer, and it is not necessary to allude to the readiness with which these gentlemen answered the questions of the visitors and pointed out the peculiarities of the instruments under their charge. A number of the visitors took the opportunity of viewing the sun with the great equatorial; and as there happened to be a magnificent spot near the centre of the disc, they were fortunate in the occasion. (This spot was well visible to the eye without optical assistance.) The willow-leaves and rice-grains were of course looked for; and each person gave his version of what he saw, or thought he saw: the day, however, was by no means clear enough for so delicate an investigation. The visitation was over shortly before six o'clock, when a portion of the party adjourned to the "Ship" at Greenwich, for purposes connected with *whitebait.*

HAS VOLCANIC ACTION CEASED ON THE MOON?

Sir,—On the evening of May 18, 1864, I visited the observatory of J. G. Barclay, Esq., in company with the Rev. T. W. Webb, author of "Celestial Objects for Common Telescopes." On turning the fine equatorial of more than ten inches aperture—object-glass by Cooke and Sons, of York—on the moon, and inspecting the crater Marius $IIC\lambda^1$, then very favourably illuminated, Mr. Webb pointed out *two* small craters on the floor as objects of interest, particularly as many such objects are not to be found on Beer and Mädler's map. On returning home the same night, I was greatly gratified to find that I could see both objects with the Royal Society's achromatic of $4\frac{1}{4}$-inch aperture object-glass, also by Cooke, and entered in my journal the following remarks:—

"Marius.—The floor, 3° of light (Beer and Mädler give 2°·5), is smooth, but has on it *two* small craters not shown by Beer and Mädler; the largest, $IIC\lambda^2$, 4° of light, is on the N.W. quadrant of the floor, and aligns with *two* small craters, one east of Marius ($IIC\lambda^3$) of 4°·5 of light: B. and M.'s estimation is 4°, and it is marked by them *c*. The other, considerably west of Marius, is between *d* and A; on Beer and Mädler's map it is IIB^{o1} in the

new nomenclature. The smaller crater on the floor of Marius, $IIC\lambda^4$, of $3^{\circ}\cdot5$ of light, is more central, and aligns with $IIC\lambda^3$ and a small crater between *c* and *d* on Beer and Mädler's map, but not shown by them."

"NOTE.—The above estimations of light depend on the following scale:—Aristarchus, the brightest parts$=10^{\circ}$. Surface around Kepler$=5^{\circ}$."

Having communicated the above results with the smaller instrument to Mr. Webb, with some remarks on Beer and Mädler's description of Marius, I received from that gentleman the following note:—

"Hardwick Parsonage: May 28, 1864.

"My dear Sir,—I rejoice in your Marius discovery, and I am not sorry for my addition (I believe it was mine?) of the smaller companion crater. The *position* considered, they (at least your *larger one*) afford as strong evidence as any we have of continued volcanic action. Beer and Mädler say that 'on the inside it is quite simple (or plain).' Whether they mean by this the absence of *terraces*, as the context implies, or of any object on the floor, does not signify; their expressions show that they observed it with care. You see also they measured the height of both sides of the wall *above the floor*, and they say 'the inner surface permits us to remark no central hill, only an extremely small peak in the N.W., divided from the wall by a narrow valley, not inserted (as you have correctly rendered it) in the map, from its subsequent discovery, as well as a very low *vorstupe*;' which I take to be, literally, a step in front (as of a doorway) on the opposite side of the wall. All this shows they took pains, as well as the assertion that the ring is composed, in *a very slight degree*, of peaks or ridges. We may be pretty sure your crater is less than thirty years old; and now it will have to be sharply measured for enlargement, and possibly the smaller one may be coming up after it. I feel much interested in this discovery, made on an evening the recollections of which are very pleasant to me. I shall look sharp after my new friends when I have a chance.

"Believe me, my dear Sir, yours very faithfully,

"T. W. WEBB."

In connection with the above letter, I have only to remark that I have no share in the discovery, further than by the references to Beer and Mädler's work. Had not Mr. Webb pointed out the objects, they might not have arrested my attention.

W. R. BIRT.

Victoria Observatory,
Victoria Park, London, N.E.:
May 30, 1864.

LESCARBAULT'S PLANET (?).

A correspondent at London, Canada, has forwarded to us a slip from an American paper, containing an account of the observation by a Mr. Samuel Beswick, of New York, of a planet which he saw cross the sun's disc on the 12th of February last, at 20 minutes past 8 in the morning: it was then 10′ 20″ from the eastern limb and 14′ 20′ from the southern limb of the sun; its motion was exactly 711″·66 in 100 minutes, and the whole time of transit was 4 hours 33·5 minutes. The size of the object was 8″; and its rate of progress across the disc exceeded that of Venus, and was less than that of Mercury. Mr. Beswick considers that this is a planet moving in an orbit between Mercury and Venus, and that from his computations it agrees with several appearances of small bodies crossing the sun, more particularly with that of Lescarbault, March 26, 1859; that of Schmidt, Oct. 11, 1847; Stark and Steinhubel, Feb. 12, 1820; Stark, Oct. 9, 1819; Fritsch, Oct. 10, 1802; and Schentan and Crefield, June 6, 1874. From these Mr. Beswick calculates the period of the planet at 126 days. He also considers that this planet will account for the supposed satellite of Venus, and that it was seen and taken for such a satellite by Cassini, Aug. 28, 1686; by Short, Oct. 23, 1740; and by Montaigne on four occasions between May 3 and 11, 1761. Mr. Beswick adds that it may be expected to cross the sun's disc on June 18, early in the morning. Our correspondent says, "I shall not attempt to speak of the merits of this paper, trusting to hear of it in the *Register*." We regret that our correspondent's communication reached us too late for our June number.

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*THE NEW EDITION OF SIR J. HERSCHEL'S OUTLINES OF ASTRONOMY.**

The seventh edition of this standard work on Astronomy has just made its appearance; and beyond the fact of its being a new edition, the work is so well known and so deservedly appreciated,

* *Outlines of Astronomy.* By Sir J. F. W. Herschel, Bart. Seventh Edition. London: Longman, Green, & Co.

that any lengthened remarks on our part would be quite superfluous. It is, indeed, a book without which no amateur or professional astronomer can consider his library complete; and as a work of reference and authority, considering the position attained in the science by its author, its claims are very great indeed. In a series of notes the author brings up the information to the most recent date, and touches upon many points which have lately given rise to much interesting astronomical discussion. Among these are the cultivation of geodesical measurements under one general system, by Captain A. R. Clarke, by which our knowledge of the true figure and dimensions of the earth has been greatly increased; the correction of the solar parallax; the solar surface, with especial regard to the "willow-leaves" of Mr. Nasmyth; the size of the lunar craters; the companions of Sirius and other bright stars; the missing and the newly-discovered nebulæ; and the movement of the solar system in space. On all these subjects the remarks of Sir John Herschel, brief although they are, will be received with great interest and attention.

CORRESPONDENCE.

N.B.—We do not hold ourselves answerable for any opinions expressed by our correspondents.

THE COMPANION OF ANTARES.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—I have the pleasure of sending you the results of a short series of measures of the fine double star α Scorpii (Antares) obtained with my $7\frac{1}{3}$-inch equatorial and parallel wire micrometer on three evenings during the present month. The resulting co-ordinates are as follows:—
$P=275^{\circ}\cdot75$, obs. 27, *w* 135; $D=3''\cdot367$, obs. 26, *w* 92; Epoch 1864·44.

I estimated the companion to be of about the $7\frac{1}{2}$ or 8th magnitude, its colour to my eye being a fine pale blue, while that of the principal star was a fiery orange red. I was under the impression that my angle of position might be rather too large, but find it to be fully confirmed by the recent measures of the Rev. W. R. Dawes, who kindly favoured me with his results. In fact, by a curious chance our angles are identical to the first place of decimals! My distance is

considerably smaller than that assigned by Mr. Dawes; but discrepancies in this element are hardly to be wondered at in the case of a star so difficult of measurement, particularly in these latitudes.

The duplicity of this star was first discovered by the late Federal General Mitchell, in the year 1846, with the large refractor of the Cincinnati Observatory; but a distinct suggestion that Antares might be a double star had been made many years previously by Professor Burg, of Vienna, in consequence of certain phenomena presented on the occasion of an occultation of that star by the moon. As the account of Professor Burg's observation may be new to some of your readers, I venture to extract it from vol. iv. of the "Memoirs of the Royal Astronomical Society," p. 646, where it is quoted from Professor Bode's Jahrbuch for 1822.

"1819, April 13.—Emersion of α Scorpii from the moon's dark limb at 12 h. 3 m. 22 s. to 23s. apparent time.

"At 23 h. 3 m. 17·1 s. apparent time [*sic*], I observed the emersion of a star 6·7 mag., which about 5 s. after suddenly appeared to me like a star of the 1st magnitude; and it is from this transition that I have dated the time of emersion. Perhaps Antares is a double star; and the first observed small one is so near the principal star, that both, viewed even through a good telescope, do not appear separated."

To this Professor Bode remarks, "Antares is no double star," and proceeds to explain the appearance as caused by the moon's atmosphere—an explanation which we *now* know to have been erroneous, while that suggested by Professor Burg was correct. It is not impossible that Professor Bode's unfortunate *dictum* may have diverted attention from a curious phenomenon, and thus have conduced to delay an interesting and important discovery for a period of about a quarter of a century.

I am, Sir, yours faithfully,
GEORGE KNOTT.

Woodcroft Observatory, Cuckfield: June 18, 1864.

P.S.—I may just refer to the fact that the appearance of the small star some seconds before that of the large star, as noticed by Professor Burg, was observed by several astronomers, the Rev. W. R. Dawes among the number, on the occasion of the occultation on March 26, 1856; and the decided blue green tint of the companion at emersion from the moon's dark limb, while Antares was still occulted, seems to show, as was remarked by Mr. Dawes, that its colour is not due merely to the effect of contrast with that of the larger star.

PERIODIC METEORS.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—In the abstract of the Proceedings of the Royal Astronomical Society contained in your last issue for June, an inadvertency appears,

which I trust you will do me the favour to correct. It is stated, namely, that meteors are more frequent in our climate in *March* than in *September*. The reverse of this is actually the fact, and theory equally requires that the opposite should be the case. As a consequence drawn from Chladni's theory (that shooting stars are cosmical bodies revolving round the sun), it may be inferred that meteors should be more common in northern climates in September than in March. Although of an arduous kind, the observations necessary to confirm this point were made as long ago as 1837 at Düsseldorf in Germany. Shooting stars were found to be more common on ordinary nights in the last half of the year than in the first, although the long and the short nights were equally divided between the two seasons, and in the exact proportion which theory requires.

Trusting that the favour by which your former notice was inserted may be extended to the present explanation, which is more fully detailed in the Monthly Notices of the Astronomical Society,

I am, Sir, your most obedient servant,

ALEX. S. HERSCHEL.

Collingwood, Hawkhurst: June 6, 1864.

THE EARL OF ROSSE'S TELESCOPE.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—A correspondent desires to know whether the Earl of Rosse has been doing anything lately.

Permit me to draw your correspondent's attention to his Lordship's elaborate memoir on 980 nebulæ, published in the "Philosophical Transactions" for 1862.

I think, when he sees it, he will agree with me that the noble Earl has not let the grass grow under his feet.

It should be borne in mind by us Saxons, that the extreme humidity of the Irish climate renders astronomical observation much more precarious on the other side of St. George's Channel than on this.

Your obedient servant,

GEORGE F. CHAMBERS.

June 13, 1864.

[An account of Lord Rosse's paper will be found at page 33 of the first vol. of the *Register*.—Ed.]

THE SUN'S PATH IN SPACE, &c.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—Why has Professor Airy stopped the sun? The Council of the Royal Astronomical Society call it "strange"—curiously enough, they also call it "logical!"—that since the Astronomer Royal found

all the parallactic calculations to be "correct," he has come to the conclusion, "that *the whole question of solar motion in space is in doubt and abeyance.*" (*Vide* Council's Rep. in Mon. Not. of R.A.S. for February 1864.) As the *only* person, I believe, who has publicly assailed the theory of solar motion in space since it was first promulgated eighty years ago, I feel entitled to ask this question, not only on behalf of astronomers, but also of the general public, who will expect to know "the reason why," and *must* be told, sooner or later.

But if solar motion in space be assumed, I must remind astronomers that all their parallactic calculations have unfortunately been made upon the assumption of a base line of merely 190 (now 182) million miles, the diameter of the earth's orbit, as if the sun were at rest; forgetting that, if the sun has been moving towards *Hercules*, this base line must have marvellously extended for all stars at right angles to the sun's path. All the estimates as to the distances of the fixed stars in all quarters of the heavens, and as to the time of the passage of their light to us, are also thrown utterly "out of gear" and into inextricable confusion by the due consideration of *all* that the hypothesis of solar motion involves.

As to *Nasmyth's Willow-Leaves*:—Since the time of Thales, there has always been some odd "slip" occurring, to give occasion for smiles at astronomers. What took place at the meeting of the R. A. S. on 8th April last is all very amusing, from the "straw-thatching" down to the "bird-seed" and "Eureka" of the patent shirt maker. But, in the *Register* for April, there is something even better worth noting, on this new chameleon-dispute, or comical version of "Eyes and No-Eyes." In Mr. Stone's letter—sent to you by Mr. Nasmyth in *confirmation* of his own observations—he (Mr. Stone) says, "My impression was, and it appears to have been the impression of several of the assistants here, that *the willow-leaves stood out* DARK *against the luminous photosphere!*" whereas, according to Mr. Nasmyth's well-known printed description and drawing, the willow-leaves are *bright*, and form the very luminous photosphere itself, the interstices being *dark!* In the same number of the *Register*, Mr. Chambers, "*knowing* what to look for," tells us he saw "glimpses," through the morning "scud," of "rice-like appearances, as described by Mr. Stone." Whether "dark" or "bright," he omits to say explicitly, so I cannot tell what Mr. Chambers wishes us to believe.

Might I be permitted to suggest, that these appearances are caused by some optical illusion in connection with the eyes of the beholders? though there is difficulty even as to this hypothesis, since it would appear that Continental eyes are not subject to the lively variations that distinguish those of our home observers. M. Drach has not explained what he meant by *his* suggestion, that our "maritime climate" may be the cause of all this. Can he allude to a consequent moisture in the eyes, which may induce all the advantages of "seeing double?" And has our poetical friend "Cyclops," with the advantage of his "single eye," no suggestion to offer on this most interesting but equally puzzling subject?

I am, Sir, your faithful servant,

T. REDDIE.

Hammersmith, May 14, 1864.

THE APPARENT CAUSE OF THE SUN'S VARIABLE DIAMETER.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—The short letter which you did me the favour of inserting in the *Register* for this month, on the "Variation in the Sun's Diameter," has been noticed by some of the members of the Astronomical Society. They are very desirous to obtain further particulars; which if you permit me, I shall be happy to give through the medium of your interesting and instructive periodical.

My friend Sir E. Belcher remarked at the *conversazione* on Saturday evening, that "the fact of the variable diameter of the sun being produced by atmospheric refraction, and not by the supposed variable distances, was known to him for many years, and that he quite agreed with my observations." Indeed, anyone who may visit the Equatorial zone and the Southern hemisphere, with a good sextant, and a vernier divided into 5″ or 10″, would necessarily arrive at the same conclusion—viz., that the variation in the diameter of the sun was produced by our atmospheric lens, which varied the sizes of the celestial bodies, and refracted their rays at a certain ratio, between the horizon and the zenith. The laws of atmospheric refraction are not yet ascertained with sufficient accuracy to be depended upon in all latitudes and altitudes; and this uncertainty has not only caused a misconception as regards the cause of the variation in the diameter of the sun, but also affects and vitiates many of what have hitherto been regarded as fundamental data of physical astronomy.

I should like to know how the maximum refraction has been computed equal to 33′, *i. e.*, in the horizon, as, according to a series of observations carried on for many years near the equator, I have only found it 16′ 30″—that is, equal to the apparent semi-diameter of the sun at its rising and setting.

The equatorial zone is very favourable for making delicate astronomical observations, inasmuch as the sky for days often remains tranquil and very transparent, and the temperature also is subject to but small variations, and the oscillation of the mercurial column very limited. These conditions are highly favourable for taking observations: therefore, I trust the following results deserve consideration and further investigation:—

	°	′	″	
The sun rising . . . ∠	0	32	55	diameter.
	15	32	35	
	30	32	18	
	45	31	55	
	60	31	32	
	75	31	6	
Noon	90	30	36	
	75	31	2	
	60	31	30	
	45	31	52	
	30	32	15	
	15	32	34	
Setting	0	32	56	

The above observations, and those following, were obtained by means of a good sextant and a repeating circle, and carried on for upwards of ten years near the equator.

In latitude 5° 10′ North, 300 feet above the sea—mean temperature 70°—I obtained the following results, measured in the meridian from tropic to tropic:—

	°	′	′	″	
South tropic ∠	61	22	31	30	Sun's diameter.
Equator . . .	84	50	30	45	" "
Zenith . . .	90	0	30	36	" "
North tropic .	71	35	31	12	" "

These variations of diameter, depending on the altitude, were subsequently confirmed by a series of observations in latitude 40° South.

Again, at Melbourne, latitude 38° South, I obtained the following results:—

	°	′	′	″	
June . . . ∠	28	22	32	20	diameter.
Sept.	52	0	31	40	"
Dec.	75	27	31	0	"

Hence it follows that the ellipticity of the earth's orbit is founded on an optical illusion, which misled Kepler at a period when little was known of the laws of atmospheric refraction, and much less any opportunity at that time, to make counter-observations in the Southern hemisphere. The supposed variable velocities proceed from the same cause: hence one illusion neutralises the effects of the other.

I remain, Sir, yours very faithfully,

E. HOPKINS, C.E., F.G.S.

June 14, 1864.

P.S.—I beg leave to correct an error in my last letter. The sun's diameter at the altitude of 22° is 32′ 22″, and not 32′ 32″, as therein inserted. The atmosphere should be perfectly transparent and serene, and the same shades employed, to insure correct results. E. H.

THE MOON'S PATH ROUND THE EARTH.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—Mr. Reddie is astounded at my ignorance of the fact that the moon's path, if drawn to a scale of an inch to a million of miles, would never diverge, by a quarter of an inch, from a circle round the sun. No doubt this is the case, as is shown by your correspondent "S. B.;" but in the illustrations generally used on this subject, the moon's path is spoken of relatively to the earth. Mr. Reddie, apparently, insists that what is said shall be founded upon abstract movements in space, and forgets that, being imperfectly acquainted with such movements, we can found no arguments upon them. Speaking of a carriage-wheel, we say, "it turns round," although it does not actually turn *round*, the movement of the carriage complicating the simple rotation of the wheel. So of the moon: we

say she revolves in "an ellipse round the earth;" which is not actually the case, because the movement of the earth complicates that ellipse.

"Ruricola" states that I reiterate the assertion that "the moon does not rotate *because* she does not. I should like him to point where I have done so. As I said before, I asked a simple question: when he has answered it, he may begin to talk of the "sex" of my argument.

I am, Sir, obediently yours,

AN ENQUIRER.

Cambridge: June 10, 1864.

LIGHT AND DARKNESS.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—The subject of Light and Darkness seems to have again become one of the great topics of discussion amongst your numerous readers and correspondents. As I am not fully aware to what extent the result of such discussions has been satisfactorily decided upon, or of the ultimate nature of the case, as agreed upon by the learned men of the day, I beg to propose one or two remarks on the subject of that question, in hopes of gaining some information from such of your correspondents as may be acquainted with the cause or true nature of Light as opposite to that of *Darkness.* 1st, How is it accounted for in the appearance of the sun *or* moon, when either rising or setting, being of a red or vermilion colour, more than when at a certain height above the horizon or in the zenith? To my mind, the reason appears thus:—The sun not being able to throw out its rays in an oblique direction (or if so, to have no effect upon the atmosphere, or upon our observation), as at right angles with the horizon, but doing so *perpendicularly,* we are not able to catch the *rays* as emanating from the sun's disc; and they not being reflected again by the atmosphere, we see nothing but a *red* globe, without perceiving the rays or beams which constitute daylight. I founded this notion upon the idea that the earth being of a *convex* form in relation to the position of the *sun,* the rays that strike down in a perpendicular, or perhaps slightly slanting direction, would, by the instrumentality of the atmosphere (which we would suppose to be of that form, or of a *concave* in relation with the *earth*) be reflected *back* again—that is to say, from the eye of the observer or otherwise—to appear as we see it at the meridian; for I do not think it is actually the *rays* of the sun that we feel or behold, but merely the reflection of the same, as caused by the intervention of the atmosphere, which is in reality an immense powerful reflector, from its being of the form described. This is proved by the reality of the sun's appearing of the same colour and condition when seen from high positions as it does when seen on the horizon. If it is not so, are we to suppose that the sun, which appears to us of a mere dull red colour, is not shining as brilliantly, as we experience it, on some other portion of the earth, either to the east or west, as the case may be? If so, why do *we* not see or feel its rays (although

we perceive it on the horizon) as strongly as when it is in the zenith? Is it because the sun is not at a sufficient height, that the rays may be reflected—say, for example, on London—until we have so moved round as to become under the *influence* of those rays, or their *reflection*, as to experience the bright glare and heat that originate from the sun? If any of your Correspondents will be kind enough to give a clear statement of those facts as necessarily comprehended, they will oblige Yours very faithfully,

OBSCURUS HOMO.

May 25, 1864.

A VOICE FROM THE SUN.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—Methinks you would confer a great boon on the learned part of mankind, as well as a great favour both to myself and most worthy sister Diana, if you would use your exertions in aid of us both by putting a stop to, or even diminishing, the number of absurd ideas and various contradictions that reign supreme in the heads of your respected race—more particularly those who pretend to overthrow the old principles and known truths adopted by the learned of years past, as regards myself. I refer to *some* of your correspondents, who, instead of sticking to the truth (as the more steady ones do), wander off to introduce *new* and ridiculous notions that are in no way conducive to their own benefit, but rather are more liable to turn them aside from it. Surely you do not mean to affirm that you received this telegram, in your office, on a particle or particles of *dust*, do you? Of course not: it was on a *ray* of *light*—part of *myself*—upon which it was borne to you. As also, do you really contend that my rays *are*, or would be, *without effect* on the different subjects of nature (as uniform with the globe on which you dwell), without the aid or intervention of that which you call atmosphere? Certainly not. Gratitude for benefits received ought to teach you better. Why is it that, when you descend a coal-pit or a deep well, and look up, you can discern the stars shining, even although it is broad daylight above you? It is because the *atmosphere* has no power to transmit the light—i. e., *my* rays, as you see it—from the ground above to where you see them from, as it does from myself to the crust of your earth. If the atmosphere can receive my rays, and therefore cause daylight, why does not the atmosphere *above* reflect the light that it has obtained on the atmosphere *below*? I do not deny its efficacy in diffusing or distributing the light from my rays on every portion of the globe that can receive them; and it is that which is instrumental in lessening the sudden light my approach would necessarily cause every time I appeared, and thereby cause great damage and injury to your earth. When you men take a photographic picture in a camera obscura, what is it that enables you to do so? Is it a number of particles of *dust* that causes the fluid to change its colour, and thereby form the picture; or is it a number of minute particles of *light* emanating from myself? For in the case of the former I fear you would be

very badly off, on the chemical principles from which you have inferred it. The atmosphere *contains* a number of small particles of *dust*, caused by the various provisions of nature for renewing and diminishing each particular substance of which the earth is composed, and is that which contributes in some degree to reflect and convey the particles of light which come in contact with them, and thus add to the benefit the atmosphere otherwise confers. I hope, Sir, your readers will be good enough either to explain themselves satisfactorily, or give it up altogether, as a matter too lofty for their ideas—as lofty as the subject of all their discussions, and as glorious as it is lofty. Hoping you will excuse this trespass on your too valuable space, I am, Sir, yours to command,

PHŒBUS.

"Space:" May 23, 1864.

THE MOON CONTROVERSY.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—I ask leave to point out the utterly groundless assumption on which your correspondents are proceeding, who deny the fact of the moon's rotation on her axis. The very phenomenon on which they rely in support of their opinion refutes them. *Speaking roughly*, the moon presents constantly the same face to the earth; but *in strictness this is not true*, and the discrepancy is destructive of their argument, which I take to be this:—"The moon has not two independent motions—one of revolution round the earth, and another of rotation round her own axis, but the former only, in consequence of which she presents, &c." Now, one part of the *librations* is due to the want of exact uniformity between the two *independent* motions, and could not exist were their theory correct. "The moon's rotation on her axis is *uniform*; but since her motion in her orbit is *not so*, we are enabled to look a few degrees round the equatorial parts of her visible border, on the eastern or western side, according to circumstances, &c."—*Herschel's Astr.* art. 435. What other explanation could possibly be given of this? It is owing to the phenomenon of the libration that stereoscopic views of the moon can be taken, and then the two different movements are in a manner made visible.

I am surprised that none of your correspondents have suggested the following experiment:—Suspend a ball from any convenient place, and having drawn it out of the perpendicular, cause it to revolve round its position of rest. If care has been taken, in starting it, not to give it an axial rotation, it will not acquire one during its revolution, but the same point in the surface will point constantly towards the same part of the room. Then the conclusion is obvious—either the moon rotates or this ball does, for (roughly speaking) the moon presents the same hemisphere to the centre of its orbit; but the ball presents a continually-changing hemisphere. Which is it that has rotated? Yours faithfully,

P.

London: June 18, 1864.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—As a subscriber to the *Register*, I have of late been sorry to see so much talent thrown away by some of your correspondents in their attempts to convince astronomers that the moon has no axial rotation. Shame on them not to believe it! What can such men as Sir John Herschel or the Rev. W. R. Dawes know about such things!

I would strongly advise the sapient non-axial rotation gentlemen to leave astronomers for the future in their pitiable ignorance, and to turn their own splendid talents to a solution of the long-vexed but interesting question—whether or not the moon is made of green cheese!—I am, Sir,

Your obedient servant,

May 1864. GAMMA.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—In this controversy, how does it happen that the third body, the sun, is never referred to? The moon moves round the earth, presenting always *the same* face or hemisphere to the earth. Some persons deny that this compound motion includes a rotation of the moon upon her axis. But to completely prove their theory or view, these deniers should go farther, and should prove affirmatively, that a body which should move round the earth, and should present to it *different* faces or hemispheres in the course of that motion, *does rotate* on its axis. The direction of the lines of the sun's light may be assumed to be parallel during one lunation. T. H.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—Taking Mr. Deey's equations of motion $x=a\cos\phi\pm e\cos\lambda$, $y=a\sin\phi\pm e\sin\lambda$, the two parameters a, e, are reducible to one in making $\lambda=\phi$, for then $x=(a\pm e)\cos\phi$, $y=(a\pm e)\sin\phi$, which involving only one parameter or radius $a+e$ denotes a single circular movement; and this is the only relation between the angles ϕ and λ which will produce it: this is precisely the case of the moon revolving round the earth at rest. In making $\lambda=\phi$ the equations of motion become $x=(a\pm e)\cos\phi$, $y=(a\mp e)\sin\phi$, and therefore $(a\pm e)^2y^2+(a\mp e)^2x^2=(a\pm e)(a\mp e)$, the equations of an ellipse, and involving two parameters $a\pm e$ and $a\mp e$ not reducible to one, indicating two angular movements in contrary directions, one of which is double the other, the well-known characteristic of ellipsic motion.

If $\lambda=2\phi$, the equations of motion become $x=a\cos\phi\pm e\cos 2\phi$, $y=a\sin\phi\pm e\sin 2\phi$, which, if $a=2e$, are the equations of the common cardiode, where the angular movements are equal and in the same direction. Reciprocally, when the angular movements are equal, but in contrary directions, the equations of motion become $x=a\cos\phi\pm e$, $y=a\sin\phi$, and therefore $(x\mp e)^2+y^2=a^2$; involving the two para-

meters a and e, and denoting an excentric circle whose radius= parameter a, and excentricity=parameter e.

Different values of e give different circles, all having the common value $2a$ for their diameters: y remains the same for all values of e, and consequently the parameter e throughout its motion remains constantly parallel to the axis of x. Whereby it is demonstrated that parallel circular motion is a compound motion, and not a simple or single movement.

Thus Mr. Deey's own equations, *when rightly interpreted*, give the same results as those of

ANALYST.

June 1864.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—Mr. J. T. Slugg has, like many more, confounded revolution with rotation. His argument will be found, upon examination, to support the opposite theory to that he intended. Let D, rotating on a stationary axis, be removed to M. As D rotates, the indicator will point at one time towards E, and at another in the opposite direction; and it is evident that, during half the period of rotation, the indicator will be visible to an observer at E, but invisible to him during the other half. "We have already seen that neither progress in rotating, nor a slow rate of rotation, in the least indicates the fact of rotation, nor in fact has anything at all to do with it." If, therefore, we suppose D to revolve about E in the same time as it takes to make one rotation on its axis, the same appearance will be presented to the observer at E; and if the indicator be a spot on the lunar surface, it will, supposing this axial rotation, appear for 14 days to the observer at E, and then, disappearing over the edge of the visible half of the moon's surface, remain for a similar period invisible to him. But this phenomenon is not exhibited by the moon, the surface of which remains the same to an observer on the earth during the whole period of her revolution. It is evident, therefore, that she does not rotate on her axis.—I am, Sir,

Yours obediently,

S. B. K.

A New Planet.—A new minor planet, the 80th of the remarkable group between the orbits of Mars and Jupiter, was discovered on the 3rd of May last, in the constellation Scorpio, by Mr. N. R. Pogson, the Government astronomer at Madras. Its position on the night of discovery, at 14h. 44m. 4s., Madras mean time, was:

Apparent right ascension..........................16h. 12m. 0·9s.
Apparent South declination........................16° 46m. 5·5s.

Its daily motion in right ascension was 50 seconds retrograde, and in declination 6½ minutes North. In brightness it was equal to a star of the 10½ magnitude. It was very near the place where Mr. Pogson discovered the minor planet Isis in 1856; and he thinks that in all probability it is identical with the planet which he found on the 6th of June, 1853, but which he afterwards missed and never recovered.

THE PLANETS FOR JULY.

Mercury passes from Taurus into Leo during the month of July, but will not be well situated for observation. It is in superior conjunction with the sun on the 17th. It rises on the 1st about a quarter to 3 in the morning, and at the end of the month sets about half-past 8 in the evening.

1st	R.A.	5 28 17	Dec. N.	22 15½	Diameter	5″·8
31st	„	9 42 51	„	15 19	„	5″·2

Venus, like Mercury, arrives at superior conjunction this month, which happens on the 18th, and this planet, consequently, is also very ill situated for observation. On the 1st it rises about half-past 3 in the morning, and sets on the last day of the month about 8 o'clock in the evening.

1st	R.A.	6 22 25	Dec. N.	23 40½	Diameter	9″·6
31st	„	8 59 32	„	18 23	„	9″·6

Illuminated portion of the disc of Venus=1·000.

Mars passes from Pisces to Aries during the month, and may be seen in the east during the latter part of the night, rising on the 1st about midnight, and at the end of the month about 11 o'clock.

1st	R.A.	1 35 21	Dec. N.	7 52½	Diameter	7″·2
31st	„	2 52 22	„	14 36	„	8″·2

Illuminated portion of the disc of Mars=0·847.

Jupiter continues to be a conspicuous object in the early part of the evenings, setting about an hour after midnight on the 1st, and about 11 o'clock on the 31st. It continues in the constellation Libra.

1st	R.A.	15 3 18	Dec. S.	16 13½	39″·4
31st	„	15 3 44	„	16 23½	36″·4

Saturn may still be seen, but is now rapidly passing from view. It continues in the constellation Virgo, and sets on the 1st about midnight, and on the 31st at 10 o'clock.

1st	R.A.	12 46 31	Dec. S.	2 17	Diameter	15″·8
31st	„	12 52 8	„	3 0	„	15″·0

Dimensions of Ring—Outer major axis, 38″; outer minor axis, 6″.

Uranus is in the constellation Taurus, but is not yet in a position for observation.

THE MINOR PLANETS.

The following are the Minor Planets which will be on, or within one hour of Right Ascension, on either side of the Meridian, between nine and twelve o'clock during the evenings of July. Their places are to be found in the Supplement to the *Nautical Almanac* for 1867.

	Magnitude.		Magnitude.
Juno	9·7	Bellona	10·7
Astræa	10·7	Euphrosyne	12·7
Victoria	8·1	Mnemosyne	11·5
Irene	10·0	Olympia	11·2
Eunomia	9·1	Erato	12·6
Psyche	9·9		

ASTRONOMICAL OCCURRENCES FOR JULY 1864.

DATE.		Principal Occurrences.		Jupiter's Satellites.		Meridian Passage.
		h. m.			h. m. s.	h. m. Jupiter.
Fri	1		Sidereal Time at Mean Noon, 6 39 9·9	1st Oc. D. „ Ec. R.	9 27 12 37 50	8 22·7
Sat	2	2 20 5 27	Conjunction of Moon and Mercury, 2° 19′ N. Conjunction of Moon and Uranus, 3° 22′ N.	1st Tr. E. „ Sh. E.	8 48 9 50	8 18·6
Sun	3	0 17 4 21 8 58 12 24	Conjunction of Uranus and Mercury, 0° 44′ S. Conjunction of Moon and Venus, 4° 22′ N. Conjuuction of Mars and o Piscium, 3m·4 W. ● New Moon			8 14·5
Mon	4			3rd Ec. R.	9 30 2	8 10·5
Tues	5					8 6·4
Wed	6			2nd Oc. D.	10 19	8 2·4
Thur	7					7 58·4
Fri	8			2nd Sh. E. 1st Oc. D.	9 51 11 17	7 54·3
Sat	9			1st Tr. I. „ Sh. I. „ Tr. E. „ Sh. E.	8 26 9 33 10 38 11 45	Moon. 4 5·6
Sun	10			1st Ec. R.	9 1 7	4 47·6
Mon	11	4 21 15 51	Conjunction of Moon and Saturn, 5° 36′ N. ☽ Moon's First Quarter	3rd Oc. R. „ Ec. D.	9 2 11 33 51	5 30·6
Tues	12					6 15·6
Wed	13	21 16	Conjunction of Moon and Jupiter, 0° 50′ N.			7 3·4
Thur	14	10 43 11 49	Near approach of Moon to 41 Libræ (6) Occultation, disappearance of κ Libræ (5)			7 54·5
Fri	15			2nd Tr. E. „ Sh. I.	10 2 10 4	8 49·1

DATE.		h. m.	Principal Occurrences.	Jupiter's Satellites.	h. m. s.	Meridian Passage. h. m.
Sat	16	 12 52 23 12	Sidereal Time at Mean Noon, 7 38 18·2 Conjunction of Venus and Mercury, 0° 40′ N. Superior Conjunction of Mercury	1st Tr. I. " Sh. I.	10 17 11 28	Moon — 9 46·6
Sun	17	23 9	Superior Conjunction of Venus	1st Oc. R.	10 55 49	10 46·1
Mon	18	18 36	○ Full Moon	1st Sh. E. 3rd Oc. D.	8 9 10 33	11 46·0
Tues	19					Jupiter. — 7 11·0
Wed	20	13 3 14 10	Occultation of C^1 Capricorni (6) Reappearance of ditto			7 7·1
Thur	21	11 13	Near approach of Moon to κ Aquarii (5)			7 3·2
Fri	22	15 43 16 26	Occultation of λ Piscium (5) Reappearance of ditto	2nd Tr. I.	10 8	6 59·4
Sat	23					6 55·6
Sun	24			2nd Ec. R. 1st Oc. D.	9 22 23 9 26	6 51·7
Mon	25	8 46	☾ Moon's Last Quarter	1st Tr. E. " Sh. E.	8 50 10 5	6 47·9
Tues	26	1 40	Conjunction of Moon and Mars, 2° 12′ S.			6 44·1
Wed	27					6 40·3
Thur	28					6 36·5
Fri	29	14 14 15 33	Conjunction of Moon and Uranus, 3° 34′ N. Near approach of Moon to χ^3 Orionis (5)	3rd Sh. I.	9 19	6 32·8
Sat	30					6 29·0
Sun	31			2nd Oc. R. " Ec. D.	9 27 9 43 31	6 25·3

TABLE OF NEBULÆ.

Right Ascension, Thirteen Hours.

NAME OF NEBULA.	Right Ascension.	Declination.
53 M. Coma Berenicis......	13 6 15	+18 53½
A beautiful large bright globular mass, condensing rapidly towards the centre.		
63 M. Canum Venaticorum	13 9 45	+42 45
A tolerably bright nebula of some size. It is of an oval form, but with ill-defined outline.		
51 M. Canum Venaticorum	13 24 10	+47 54
A remarkable double nebula. Each of the components has its own nucleus, but the nebulosities coalesce.		
3 M. Canum Venaticorum	13 35 55	+29 3
A brilliant, large and beautiful object, blazing up in the centre.		
187 Hersch. i. Can. Venat.	13 50 55	+47 54½
Dim and uninteresting.		
101 M. Böotis	13 58 25	+55 1
Exceedingly dim and faint.		

Of the objects described in the Table above, the first, third, and fourth will most attract the observer. 53 M. Coma Berenicis is a bright globular mass, exhibiting that peculiar glow and glitter indicative of resolvability. 51 M. Canum Venaticorum presents a very singular appearance, consisting as it does of two nebulæ, each with its own nucleus, but with their nebulosities running into each other. A diffused mass of haze extends round the southern one (which is consequently considerably the larger of the two) like a ring. 3 M. Canum Venaticorum is a glorious object, blazing up in the centre, and exhibiting palpably the glitter of star-dust. 63 M. Canum Venaticorum is tolerably bright and of some size, but our remaining two nebulæ are not worth looking at.

By a typographical error in the May number, the words "a star in a *brier*" were printed for "a star in a *burr*."

Right Ascension, Fifteen and Sixteen Hours.

NAME OF NEBULA.	Right Ascension.	Declination.
219 Hersch. i. Draconis .:.	15 2 45	+56 17
A tolerably bright oval nebula, lying N.P. and S.F. in the field of view.		
22 M. Draconis	15 5 30	+57 30½
A small nebula, overpowered by a minute star to the N. of it.		
19 Hersch. vi. Libræ	15 9 30	−20 32½
A dim pale haze of considerable size, surrounded by stars at some distance.		

5	M. Libræ	15 11 40	+ 2 35½
	A glorious object! blazing towards the centre, and glittering with star-dust.		
759	Hersch. ii. Böotes	15 12 20	+56 48½
	Very dim; seen with difficulty.		
764	Hersch. ii. Draconis...	15 36 25	+59 47
	Very small, pale and round, but better defined than the last object.		
80	M. Scorpii	16 8 55	−22 39½
	A splendid nebula, bright, globular, and condensing rapidly towards the centre.		
4	M. Scorpii	16 15 20	−26 11
	A large nebulous mass.		
40	Hersch. vi. Ophiuchi...	16 25 0	−12 44½
	Large and pale, with scarcely a sign of condensation.		
13	M. Herculis	16 36 50	+36 43
	A most gorgeous object! resolved into one superb glittering mass of stars.		
Struve 5	N. Herculis	16 38 50	+24 3
	A small but very bright planetary nebula.		
12	M. Ophiuchi	16 40 15	− 1 43
	A very large nebulous-looking mass, but evidently resolved.		
50	Hersch. iv. Herculis ...	16 43 5	+47 46
	A planetary nebula of some size, but quite faint in comparison with Struve 5.		
10	M. Ophiuchi	16 50 5	− 3 54½
	A very fine resolvable nebula; it is less than 12 M.		
62	M. Scorpii	16 52 40	−29 53½
	A bright object, but very close to the horizon.		
19	M. Ophiuchi	16 54 15	−26 4½
	A beautiful, bright, glowing object, with indications of resolvability.		

The Fifteenth Hour of Right Ascension derives its chief interest from containing that very beautiful object, 5 M. Libræ, which, blazing towards the centre, and glittering with the star-dust into which it is resolved, extends out from its brilliant nucleus in all directions. The remaining nebulæ in this hour, with perhaps the exception 219 Hersch. 1 Draconis, are of no great importance. In the Sixteenth Hour, however, will be found several nebulæ which will at once arrest the attention of the observer with their size and brilliancy. Foremost among them is that superb one, 13 M. Herculis, which on a dark night presents truly a godlike sight—one gorgeous glittering mass of exceedingly minute stars. No diamond jewel ever equalled

it in splendour! 80 M. Scorpii, 4 M. Scorpii, 12 M. Ophiuchi, 10 M. Ophiuchi, 62 M. Scorpii, and 19 M. Ophiuchi, may all be cited as fine examples of nebulæ more or less resolvable. The proximity of some of them to the horizon, however, greatly interferes with their observation, as in the case of 62 M., which, when on the meridian in London, is less than 9° high. It will be noticed that there are two planetary nebulæ in this Hour. One of them, Struve 5 N. Herculis, is small but remarkably bright. It is noticeably so, even with the very highest powers. The other, 50 Hersch. N. Herculis, although of some size, is quite faint in comparison with it.

SOLAR PHENOMENON.—While observing the sun with a 4-ft. Fraunhofer, on the 12th of March last, Dr. Weisse noticed that a group of spots had become much larger, and was composed of two spots, both bordered by penumbra, and that one was partially concealed by the penumbra of the other. In order to prevent mistake, several powers were used, but the darker penumbra of the first spot continued to hide the lighter penumbra of the other.—*Astronomische Nachrichten.*

INSTRUMENTS, &c. FOR SALE.

These Notices, which are restricted to *three lines* each, are inserted free of charge to Subscribers: applications respecting prices and other particulars to be made to the Editor, with a stamped envelope for reply, without which *no answer can be sent.*—For Advertisements with prices and more complete details, a small charge will be made.

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TO CORRESPONDENTS.

N.B.—Articles received after the 20th of the month cannot be inserted unless containing notices of fresh discoveries, or otherwise of immediate interest.

G. J. J., Colchester.—In our next number will be found a *Catalogue of Variable Stars*, prepared expressly by G. F. Chambers, Esq.

In answer to numerous enquiries, we may state that the *Monthly Notices* of the Astronomical Society are only to be obtained as published by Fellows of the Society. They cannot be purchased separately.

Communications from "H." "W.," "One who is Moon-stricken," "E. H.," and "B.," postponed for want of space.

Our Subscribers will notice the alteration in the publishing office of the *Register*. Messrs. *Adams & Francis*, of 59 Fleet Street, will henceforth take charge of this department. Gentlemen who have not yet paid their subscriptions to June are *particularly requested* to forward them as soon as possible to the Editor, at Stamford Villa. Subscriptions beyond that date are to be paid to Messrs. Adams & Francis.

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Freeman, D. A., Esq., Temple.
Hulley, Jasper, Esq., the One House, Macclesfield.

ASTRONOMICAL REGISTER.—*Subscriptions received for the year* 1864—the Editor's list.

To June.

Birt, W. R.
Brothers, A.
Darby, Rev. W. H.
Field, H.
Mart, S.
Potter, T. jun.
Robertson, C.
Smyth, Prof. C. P.
Smelt, Rev. M. A.
Taylor, Mrs. J.
Williams, G. (Holl).
Williams, H.

To September.

Freeman, D. A.
Herschel, A. S.

To December.

Gilby, J.
Knott, G.
Noble, Capt. W.
Prince, C. L.
Redpath, H. S.
Main, Rev. R.
Lewis, R. T.

June 28, 1864.

CONTENTS.

The Astronomical Register.

No. 20. AUGUST. 1864.

ON THE LIGHT OF THE SUN AND STARS.

A paper by Mr. Balfour Stewart, on the *Large Sun Spot Period of 56 years*, was communicated to the Royal Astronomical Society at the last meeting; and its author has extended it by a paper in the *Intellectual Observer* for July.

If it is admitted that a connection exists between the radius vector of Jupiter and the solar spots, so that there are most spots when Jupiter is at the greatest distance from the sun, it is natural to suppose that when Jupiter and Saturn are in aphelion together a still larger production of spots will ensue. Now, according to Professor Wolf, the maximum of the great sun spot period happened in 1836, and Jupiter was in aphelion between 1839 and 1840, Saturn between 1841 and 1842—the mean of these dates being not far removed from 1836. Mr. Stewart goes on to say:—"We are perhaps entitled to conclude that, in our own system, the approach of a planet to the sun is favourable to luminosity, and especially in that portion of the sun which is next the planet. A confirmation of this law is found in the readiness with which it may be adapted to other systems. Let us take variable stars. The hypothesis which, without being physically probable, gives yet the best formal explanation of the phenomena there presented is that which assumes rotation on an axis, while

it is supposed that the body of a star is from some cause not equally luminous in every part of its surface. Now if, instead of this, we suppose such a star to have a large planet revolving round it at a small distance, then, according to our hypothesis, that portion of the star which is near the planet will be more luminous than that which is more remote, and this state of things will revolve round as the planet itself revolves, presenting to a distant spectator an appearance of variation with a period equal to that of the planet. Let us now suppose the planet to have a very elliptical orbit; then, for a long period of time it will be at a distance from its primary, while for a comparatively short period it will be very near. We should, therefore, expect a long period of darkness, and a comparatively short one of intense light, precisely what we have in temporary stars. Again, we have seen that in many binary systems there is a change of magnitude, and that perhaps both members change at the same time and in the same direction—a result in favour of our hypothesis; but it is to be regretted that we have not yet sufficient data for determining if the brightness is greatest when both members are nearest together. Perhaps it may now be asked, If the sun have not a large store of heat in himself, but is fed from moment to moment, have we any guarantee for the continuance of his light, or for its steadiness, which is almost of equal importance to our well-being? We reply that our sun is not the member of a binary system of small period and large ellipticity, which might give him a variable brightness, nor is he surrounded by planets that now press near to him and anon recede to a great distance, which might produce the same result. No doubt we encounter occasionally an erratic comet, and are much puzzled by its great luminosity and, in other respects, strange behaviour, as it approaches our sun; but the influence of a body of such small mass upon our luminary is probably unappreciable." Mr. Stewart, in conclusion, considers that the approach of two heavenly bodies produces light, in the same manner as the approach of two atoms; and it may be "merely that arrangement by means of which the visible motion of bodies is converted into light and heat, which we know, from Professor Thomson, are the ultimate forms to which all motion tends."

HAS VOLCANIC ACTION CEASED ON THE MOON?

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—During the last lunation (June and July) I have ascertained that the small crater $\Pi C\lambda^3$, with which $\Pi C\lambda^2$ aligns (see ante, p. 159), may be included in the same category as $\Pi C\lambda^2$; and if it can be satisfactorily established that $\Pi C\lambda^2$ is really a recent instance of volcanic or eruptive action on the moon's surface, then the evidence is quite as strong that the crater $\Pi C\lambda^3$ is also an instance between the epochs of Schröter and Beer and Mädler. I am greatly indebted to the Rev. T. W. Webb for an inspection of the engraving of Schröter's drawing of the 27th of October, 1792, in which he has depicted numerous mountain points extending rather considerably east of "Marius," and to these points he has referred in his text. The whole region appears to have been surveyed by him with great care, but there is not in his drawing the most remote trace of the crater $\Pi C\lambda^3$, which is very plain on Beer and Mädler's map, marked by them *e* (not *c*, as given in my letter), and especially referred to by them in their text. This crater, which is quite perceptible with the Royal Society's 4½-inch achromatic, power 230, was seen by me without difficulty, and employed to fix approximately the position $\Pi C\lambda^2$. If $\Pi C\lambda^3$ has *not* been overlooked by Schröter, it must have been produced between 1792 and the year of Beer and Mädler's observations.

The increasing attention that is likely to be given to the moon's surface will, I have no doubt, contribute largely not only to the settlement of questions such as head this letter, but also to introduce a species of physical lunar observations of much greater precision than has yet been attempted, especially as regards the more minute objects. In connection with the enquiry respecting the Earl of Rosse's telescope, I can add my testimony to that of Mr. Chambers as to the work it is doing. His lordship has just presented me with photographic copies of those drawings of portions of the moon which have more especially engaged my attention, and I have great pleasure in bearing witness that, without exception, they are the most accurate drawings that have yet come under my notice. The

letterpress accompanying them is also so explicit that future observers cannot be misled by them.

For the complete solution of the question as to the cessation or otherwise of eruptive action on the moon, something more is necessary than the comparison of existing delineations. In some instances, as in the case of $IIC\lambda^3$, the evidence may be so strong as scarcely to admit of doubt; on the other hand, the slightest indication of hasty observation, by which small objects may be *overlooked*, necessarily throws a doubt over many observations that otherwise might be regarded as possessing considerable accuracy. Although Beer and Mädler surveyed, as there is every reason to believe, the region of "Marius" with great care, they failed to detect a small crater, $IIC\lambda^5$, on the S.W. rim of "Marius," which had been figured and described by Schröter. This crater I readily saw *on looking for it* with the Royal Society's 4¼-inch achromatic, and could discern it with a smaller instrument, the R.A.S. Sheepshanks telescope, No. 5. The absence of any note in Beer and Mädler's work, relative to Schröter's observation of $IIC\lambda^5$, is greatly to be regretted, as had they left on record that they had looked for, but could not see it, the evidence of the recent formation of $IIC\lambda^2$ would have been considerably strengthened. Not only should all existing drawings be carefully compared, but the record of the observations, in the form of a catalogue, should include all the objects inserted in the drawings *that can be found*. Notes should be made of those that cannot be found; and on occasions on which a given area may have been exhaustively examined, such exhaustive observations should be recorded so explicitly that future observers may rest assured that, with the apertures and powers employed, nothing was detected beyond the objects catalogued.

I have met with a curious class of differences between my own observations and Beer and Mädler's map. In some instances in which they give small mountains I have found small craters. Such objects are very interesting.

I am, Sir, your obedient Servant,

W. R. BIRT.

Hartwell Observatory, July 11th, 1864.

P.S. You will oblige me by correcting a slight error in punctuation. On the last line of p. 159 the semi-colon should be inserted after the word *map*, not after A. It now reads as if the symbol $IIB^{\circ 1}$ were on the map.

NEW COMET.

A new Comet was discovered by M. Tempel on the 5th July, its position at the time being R.A. 2h. 57m., Dec. + 18°12'., at 2h. 15m. in the morning. At the time of discovery it resembled a diffused nebulosity, about three or four minutes in diameter. Mr. Hind, writing to *The Times*, on the 16th, says that it was discovered simultaneously by M. Tempel, at Marseilles, and Professor Respighi, at Bologna:—"It appears likely to become an object of considerable interest about the middle of August. From the Bologna observation of the 6th, one at Leipsic on the night of the 10th, and a third taken with Mr. Bishop's refractor on the 14th, an approximate orbit has been computed by Mr. C. G. Talmage, of this observatory. It would be unsafe in this case to venture upon any definite prediction of the future circumstances of the comet's appearance from present data, but they are sufficient to indicate that it must approach near the earth about the time of inferior conjunction with the sun, in the middle of the ensuing month, probably with a latitude high enough to allow of it being observed morning and evening for some days, and with a degree of brightness eight or nine hundred times greater than on the 14th, when it was by no means a faint telescopic object. Its orbit is remarkable for its near coincidence with the plane of the earth's path, the inclination being little more than 2 deg.

"The observations of the 14th gave the following position:—At 12h. 57m. 39s., mean time at Twickenham, right ascension, 3h. 2m. 34s., north declination, 19° 14' 36"."

Mr. Hind adds that the comet is one which has not been computed before.

The following calculated position for this comet is by M. Lesser of Altona:—

	R.A.				DECL.		
	h.	m.	s.		°	'	"
July 31 . .	3	56	1	. . .	+ 25	11	0

The daily motion is + 10^{m} in R.A. and + 1° in Declination.

SPOTS ON THE SUN.—M. Schwabe has just published his results for 1863. He observed the sun on 330 days, on only two of which no spots were seen. Altogether 124 groups were recorded.

CORRESPONDENCE.

N.B.—We do not hold ourselves answerable for any opinions expressed by our correspondents.

THE FOUCAULT PENDULUM EXPERIMENT.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—As the "Moon Controversy" seems to have culminated, and I would fain hope has exhausted itself, it has occurred to me that some notice of the *Foucault pendulum experiment*, as an additional proof of terrestrial axial rotation, would be a suitable subject to occupy a small portion of the space in the *Register* thus set at liberty. What I was thinking of is, whether some one able and willing to communicate, and who has thoroughly mastered the subject so as to make the experiment uniformly satisfactory, might be induced to give a statement of all the conditions necessary to be complied with in order to uniform success. In Professor Arago's *Popular Astronomy*, numerous particulars are given, with cuts; he recommends suspension by steel wire: it seems to me, although I feel not qualified to give an opinion, that the cord of suspension, although it should originally be perfectly free from torsion, should most easily admit of it. I find many of those who have seen the experiment tried, even in large towns and under the auspices of public bodies, are sceptical, and doubtful even whether there be anything in it. I am not at all with these, although I have not yet succeeded in it perfectly and uniformly. If it be possible, however, I hope to do it. The subject generally is pretty extensively discussed and the theory of it explained, in the *Mechanics' Magazine*, vol. 54, 1851.

I am, &c.

Thornton-in-Craven, T. W.

1864-5-24.

ACHROMATIC OBJECT-GLASSES.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—The *Astronomical Register*, No. 19, has just been placed in my hands.

I find it there stated, as affirmed by me, that the variation in the refractive index of Messrs. Chance's glass (that is, glass supposed to be the same commercially) amounted to as much as 10 per cent. This was evidently a mistake: I should have said 1 per cent.

Will you please do me the favour to correct this?

I am, Sir, yours respectfully,

138 Fleet Street, JAMES SIMMS.

July 4, 1864.

THE SATELLITES OF SATURN.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—I would suggest that it would be a great boon to many amateurs, if a table showing the positions of the satellites of Saturn at the hour in each evening most favourable for their observation, with a list of transits and eclipses (similar to those in *Hannay's Almanac* of Jupiter) could be published in the *Register*; or even if published on an extra sheet, as a supplement, many would doubtless be quite willing to pay a trifle extra for so great an accommodation.

I am, Sir, yours faithfully,

Streatham Hill, July 5, 1864. S. B. K.

[We hope to be able to adopt some plan in furtherance of the desire above expressed before next opposition of Saturn, although the position of the planet will be so low as to render observations of the satellites difficult.—Ed.]

ON THE MISAPPLICATION OF SCIENTIFIC TERMS.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—I presume that the object of a scientific periodical is not only to disseminate the opinions and hypotheses of our scientific men, but also to furnish satisfactory explanations on dubious questions, and render the subjects clear to common-sense. It is to be hoped that our philosophers, at least, will always be ready and happy to enlighten any of your correspondents in a becoming spirit, when they respectfully apply for information or explanation on any point which they might not comprehend. It is somewhat painful to observe the tendency of some writers to ridicule plain questions instead of giving discreet answers; but I trust such an abuse of scientific discussions will not again appear in your valuable pages.

The remark made in the letter which you did me the favour of inserting in the *Register* for this month, with reference to the misapplication of the terms *rotation* and *revolution*, improperly used as synonymous by eminent scientific writers, has caused enquiry, and I am called upon to prove the assertion. I trust, therefore, you will permit me to quote two examples to confirm my statement.

In Herschel's *Outlines of Astronomy*, 5th Edition, article 434, On the Moon:—"The remarkable coincidence of the *two rotations*, that about the axis and that *about the earth*," &c. The motion of the moon round the earth is thus represented as rotation!

In the *Nautical Almanac* for this year, page 511, we find the following:—"The *revolution* of the earth on *its axis* is always performed," &c.

The rotation of the earth on its axis is incorrectly called revolution. I could quote other instances of such misapplication of these terms in the writings of the Astronomer Royal and others; but I hope the

above will be sufficient to satisfy your readers that my observation was strictly correct. Kepler was a geometrician and an astronomer, and justly remarked that "the moon *revolved* round the earth, but was *not endowed with rotation*."

At that period the simple "circular motion" was not trammelled by any imaginary tangential forces or straight lines, which subsequently led to the confused and unsatisfactory unity of the composition of forces and the laws of geometry, which are incapable of being proved correct to this date.

I am, Sir, yours very respectfully,
E. HOPKINS, C.E., F.G.S.

15 Clarendon Gardens, Maida Hill, W.
May 18, 1864.

THE MOTION OF THE MOON: CORRESPONDENCE BETWEEN MR. REDDIE AND THE ASTRONOMER ROYAL.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—I do not understand how "An Enquirer" reconciles his language in the *Register* for July with that in the May number, nor even one part with another of his last letter. In May he spoke of my "*theory that the moon*, like the earth, *travels in a circle round the sun*." In July he admits this to be the fact, but calls it a fact with which we are "imperfectly acquainted," being merely the moon's "abstract movement in space," upon which "we can found no argument!" He afterwards speaks of the moon's path round the earth as "an ellipse," but an ellipse complicated by the movement of the earth! In reply to this I will only observe that, if we accept the heliocentric hypothesis, and admit the earth's distance from the sun, and its velocity as usually given, also the moon's distance from the earth and her apparent motions, there is simply nothing in science with which we may be so *perfectly* acquainted as the *actual path* of the moon in a month. It is certainly not an ellipse, but a slightly waved arc of about 30°, the curvature of which is exceedingly small. In describing that arc the moon turns right round once upon itself, and *by that means alone* keeps one side always to the earth. These are the actual facts, *ex hypothesi*. The actual motion is the *only* "motion" of a body. Relative motion is merely "apparent," not real. Of course I admit —for who can deny?—that the moon *appears* not to turn on her axis in going round the earth; and I admit, moreover, that this would be an actual fact if the earth were at rest in space. I have really nothing more to say to the Cambridge "Enquirer."

But I believe I can now interest your readers with a correspondence on some still more important points connected with the motion of the moon. On June 6th I ventured to write to the Astronomer Royal, with reference to his admirably lucid "Six Lectures on Astronomy" (on which I intend publicly to comment), in order to indicate to him the nature of the issues I shall raise. With your permission I will here give some brief extracts from my letter, with the whole of Pro-

fessor Airy's clear and courteous answer, by which your readers will have before them the views of the highest living astronomical authority on the issues raised.

After some introductory matter, I said:—

"In p. 176 of the Lectures (fig. 56), it may be considered we have the working out of Prop. IV. Theor. IV. of Newton's *Principia*, B. III., and what constitutes the unfortunately false basis upon which the famous 'problem of the three bodies' has invariably been solved. . . . My primary argument against this, and the main principle of all my reasoning, will be that the physical or dynamical laws of astronomy can *only* deal with the real or absolute motions of the heavenly bodies, *not* with mere relative or apparent motions; and that the real motions of the moon, both as regards velocity and path, are utterly disregarded in these propositions."

"In p. 177 of the Lectures, the real motion of the moon being thus disregarded, her velocity is represented as only equal to 0·6365 of a mile in 1″=2,288 miles an hour. I object, that on the heliocentric hypothesis, taking the radius of the earth's orbit as=95,000,000 miles, and its mean motion as 68,000 miles an hour (as in the Lectures), then the moon's motion is 30 times greater than above represented."

"The '*circumference* of the moon's orbit' is in the same place spoken of (as if it described a circular or oval path each lunation), and is represented as only 1,500,450 miles in a month, whereas the moon's real path in a month is only an undulating curve, crossing and re-crossing an arc of between one-twelfth and one-thirteenth part of the orbit of the earth, and in round figures, is 30 times greater than represented, or equal to more than 45,000,000 miles in a month. . . Again, on p. 184 of the Lectures, the whole argument is only tenable if based upon the hypothesis that the earth is stationary and the moon moving in an oval orbit round it every month. . . . .

"I will only further trespass on your time by observing that when the moon is in conjunction, and when (as stated in the Lectures) the sun's attraction upon it is greatest, it is precisely then . . . that the moon begins to move *away* from the sun with *increasing velocity, as if repelled* . . . or 'the reverse of what would result were there really an attractive influence exercised upon her by the sun.' And not only so, but the very direction of her motion is also reversed by this fictitious hypothesis, as exhibited in fig. 59 of the Lectures. Every astronomer must know that the moon's real motion is always *direct*. . . . In fig. 59 of the Lectures her path is represented as retrograde, when in conjunction and between her last and first quarter; as going, in short, at the rate of 2,288 *miles* an hour *to the right*, in a path greatly curved and *convex* to the sun, when in reality she is moving *to the left*, in a totally different curve, which is *concave* to the sun, and then she is so moving with 30 *times greater speed* than the 2,288 miles an hour assigned to her in the Lectures." &c.

The Astronomer Royal's reply was as follows:—

"Royal Observatory, Greenwich, June 7, 1864.

"Sir,—I am obliged by your courtesy in sending me three pamphlets, and by the trouble which you have taken in your letter of

June 6, in indicating certain points to which you wish to call my attention.

"I cannot at any length enter into the matter; but I will merely observe that much of what you say is quite correct, but that the difficulties which you have founded thereon are incorrect. It *is* true that the earth and the moon are two independent planets circulating round the sun, but under circumstances which make their perturbations excessively large, so large as to give the appearance or relative fact of the moon circulating round the earth. It *is* true that the moon, as a planet, has the large velocity round the sun of which you speak. But it is *also* true that, inferring relative forces from the differences of absolute forces (which on mechanical principles is perfectly correct), and inferring relative motions from the difference of absolute motions (which on geometrical principles is necessarily correct), there is no error in treating the moon as describing an ellipse round the earth, perturbed by the difference of sun's force on earth and on moon, and there is no error in speaking of the moon's relative velocity round the earth as the small velocity in such an ellipse.

"The failure in your reasonings is simply the want of the steps for inferring relative force and relative motion from absolute force and absolute motion; and this seems to go through the whole.

"You can, perhaps, understand that, as a very closely-occupied man, I cannot enter further into this matter.

"I am, Sir, your obedient servant,

"J. Reddie, Esq." "G. B. Airy.

I will only add, that I replied by return of post to this courteous letter, "respectfully to indicate some of the grounds upon which—clearly apprehending the nature of the issues—I shall still venture publicly to maintain that, while admitting that relative or apparent 'motions' may (nay, *must*) be inferred from the differences of absolute motions, this cannot affect the *actual forces* and *velocities*, or the *directions of motions*, by which independent moving bodies can alone be influenced," my whole argument having reference to the *physical* laws of astronomy.

I am, Sir, your very faithful servant,

J. REDDIE.

Hammersmith, July 18th, 1864.

THE MOON CONTROVERSY.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—Your correspondent, "Query," requests, in the last number of the *Register*, a categorical answer to the following three questions:—

1st. In rotation on an axis is it not necessary that the axis shou d be within the body rotating?

2nd. That one side of the rotating body shall travel in an opposite direction to that of the other side?

3rd. That all objects at a distance shall appear to be travelling in

opposite directions to that of the direction in which the outside of the rotating body travels?

In reply to the 1st question, rotation on an axis of course means an axis within the body. In philosophical language a body moving freely in space is capable of two kinds of motion, namely, one termed a motion of translation referred to axes fixed in space and outside the body; the other, a motion of rotation about axes fixed *in* the body and moving within it.

In reply to the second question, if one point of a rigid body is moving in a given direction, every point of that body rigidly connected with it must of course be moving in the same direction. I cannot conceive how your correspondent could think that one point of a body could travel in one direction, and another point in the same body in an opposite direction.

As to the third question. If a body is moving in a given direction, every object outside of it would appear, to a spectator on the moving body, to be travelling in a direction opposite to that in which the body is going; from this last point may be deduced the best proof for the double motion of the moon, viz. one a motion of translation with respect to the earth, which is outside of it, and another of rotation about an axis in itself, in a contrary direction to the first; for if only the motion of translation existed, say from left to right, the earth would appear, to a spectator in the moon, to be moving from right to left, and would therefore quickly pass out of his range of vision, whereas we know that the same spot on the moon is always presented to the earth; but the other motion of the moon, viz. that of rotation on its axis from right to left, would cause the earth to appear to move from left to right, and would therefore cancel the effect of the motion of translation, which made the earth appear to move from right to left. Hence the two motions of translation and rotation, in opposite directions, cause the earth to appear fixed, to a spectator standing on the same spot in the moon, and this is the effect which we know to be produced.

Q. E. D., A. CAMBRIDGE GRADUATE.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—In speaking of a subject as delicate as that of the moon, we ought to consider—with the ancient Romans—that all due deference and honour are worthy of being assigned to its presiding deity, that is, in point of refinement and gallantry we ought to take more pains, and endeavour to adjust and reform the *truth* from the various absurd ideas that have crept in among us; and to speak of the different effects peculiar to the moon in a systematic and reasoning point of view, and not in a rambling, shuffling kind of way, which some of us are liable to do. If it were not practicable to carry out the idea an M.A. has given us, of having a "public meeting," would it not be easier to ascertain on which side the majority of votes lay, by referring to the different statements and letters of your various correspondents with regard to the moon controversy? Allow me to suggest an idea that (if possible to be carried out) might disprove or confirm the various opinions of any individual, of course including those of your correspondents. Let us construct, or imagine to be so, a sort of machine

that would illustrate the motions and peculiarities of our earth and the heavenly bodies. 1st. Let there be a round globe, or if not that, a frame, sufficiently large to contain a man (fastened in) with his head projecting out to illustrate the earth and an observer on the earth. Let this frame be placed upon an axle or two pivots, and let it be turned round slowly to represent the *diurnal* motion of the earth; while turning round on its axis, let it be also carried round a *centre,* to illustrate the motion of the earth with regard to the *sun* or its *annual* motion. Next, let a small globe be placed so as to represent the *moon,* and let it also partake of some motion, whether it be on its *own* axis, or in a motion similar to the earth. Then put a strong light *above,* likewise to represent the *sun.* Let the rays emanating from it strike on the small globe (or moon) so as to lighten up one half and leave the other in darkness: we should then ascertain the mode in which the moon appears to us when either a *new* moon or *full,* or even in the medium. If the results do not appear as we see it naturally, by letting it turn on its *own* axis, then let it be tried by allowing it to turn in a way similar to ours "*alone.*" The experiment, I confess, would seem rather difficult to prove, but I should think would be the only way of *proving* the subject under discussion. Apologising for trespass on your space,

I remain, Sir, yours faithfully,

"ONE WHO IS MOON-STRICKEN."

London: June 2, 1864.

THE GREAT METEOR, seen over a large part of France on the 14th May., at eight o'clock in the evening, appears to have pursued a nearly south-westerly course, and to have exploded over the village of Orgeuil. Its apparent size was about equal to the full moon, its light extremely vivid, the noise produced by the explosion being very loud, and not heard until several minutes after the disappearance of the Meteor. The height of the Meteor at the time of explosion is judged to have been about 15 miles. Some of the fragments which fell at Orgeuil have been collected and analysed—their external aspect resembling earthy lignite, with crystals of magnetic pyrites distributed through its mass. Some further particulars of this interesting body were given by MM. Laroque and Bianchi, at the meeting of the Academy of Sciences in Paris on June 20th; it also formed, on the 27th, the subject of a letter from M. Lespiault, who has occupied himself chiefly in determining its path.—*Reader.*

SUPERIOR CONJUNCTION OF VENUS.—In a letter dated July 5th, Mr. W. L. Banks, of Ealing, states that on that day at noon he observed Venus, being then within thirteen days of her superior conjunction, and only 3° 30′ from the sun. The telescope used was of 5 ft. focus, with aperture reduced to 3 inches. "Were it not too late," Mr. Banks adds, "it might interest your readers to watch how close she can be observed at the superior conjunction, with average-sized instruments. On this occasion she was very faint, and the sun's light intensely great."

NEW MINOR PLANET.—In a letter to the Astronomer Royal, Mr. R. N. Pogson, of the Madras Observatory, describes a new Minor Planet, first seen on May 2; "but its planetary nature was not suspected until the following night. Its partially reduced positions then, and its approximate last recorded place, are—

	MADRAS M.T.			APP. R.A.			APP. N.P.D.		
	h.	m.	s.	h.	m.	s.	°	′	″
May 3 . .	13	44	11	16	12	3·4	106	47	11
" . .	14	44	4	16	12	0·9	106	46	55
" 12 . .	12	30	0	16	4	9	105	46	0

Daily motion, R.A—53^s Dec. + $6\frac{3}{4}'$ Magnitude=10·4

Freia was observed on twenty-five nights; this one, so far, on four."

TRANSIT OBSERVATIONS BY GALVANISM.—M. Leverrier has sent a communication to the Astronomical Society, stating that his intention, in the conversation alluded to at the meeting of the Society in May (*Astronomical Register*, vol. ii. p. 128), was only to express that, in his opinion, a *touch* observer does not acquire the same appreciation of the duration of time as an observer trained to eye and ear observations. Although the discussion at the meeting appears to have been correctly reported, the Council regret that they have given publicity to a citation of an oral conversation, which conveys to some extent an erroneous statement of the views of the illustrious Director of the Imperial Observatory of Paris.

OBSERVATORY AT PEKING.—Before we left Peking, on the morning of the 12th, we procured an order of admission to the Observatory on the east wall. The way was through the house of the keeper, up a winding flight of stone steps to a platform higher than the wall. The astronomical instruments were numerous, finished with a nicety impossible to surpass, and mounted on Chinese designs of great beauty and exquisite workmanship. I saw no glasses for observing the heavenly bodies, which surprised me, as the neighbouring nation of Japan is famed for their construction. The heavens were depicted on a magnificent bronze globe by raised stars of solid brass, displaying more knowledge than the Chinese are supposed to have possessed. Indeed, these instruments were planned and constructed under the direction of Jesuit missionaries, though no small credit is due to mechanics who could finish so inimitably such difficult and delicate work. There was an artful combination of lightness with strength in the bronze work, the sextants being mounted on the shoulders of fantastic dragons."—*Mrs. Muter's Travels in India, China, &c.* vol. ii. p. 163.

DR. STEINHEIL'S TELESCOPES.—Mr. De la Rue reports most favourably of the performance of a telescope of new construction, sent by Dr. Steinheil for exhibition at his reception, at Willis's Rooms, on June 11th. The aperture was $4\frac{2}{10}$ inches, and the focal length only 40 French inches. This telescope has been purchased by Mr. F. W. Radford. Dr. Steinheil is now engaged upon a telescope of 6 inches aperture, and only 30 inches focus.

A CATALOGUE OF VARIABLE STARS.

The following list has been compiled with much care and trouble; but it is by no means an easy matter to obtain accurate information on the subject. My best thanks are due to Mr. Baxendell, not only for kindly supplying many facts not obtainable from ordinary sources, but for revising the whole Catalogue. The symbol < signifies that the star's minimum magnitude fell *below* that given, but how much is unknown. I need scarcely say that I shall be glad to receive addenda and corrigenda of a trustworthy character.

George F. Chambers.

2, Palace Gardens Terrace, Kensington:
June 1864.

No.	Star.	R. A. 1870.			Decl. 1870.		Period.	Change of Magnitude.		Discoverer.	
		h.	m.	s.	°	'	days.	From	to		
1	R Andromedæ	0	17	10	+47	51·0	..	6		Argelander	1860.
2	T Piscium	0	25	17	+13	49·3	143±	9·5	11	R. Luther	1855.
3	α Cassiopeiæ	0	33	9	+55	49·4	79·1	2	2·5	Birt	1831.
4	U Piscium	0	37	34	+ 6	35·1	..	9	12	Hind.	
5	S Cassiopeiæ	1	10	9	+71	54·2	..		13 <	Argelander.	
6	S Piscium	1	10	46	+ 8	14·2	13m. ±	9	13	Hind	1851.
7	R Piscium	1	23	56	+ 2	12·1	343	7	9·5	Hind	1850.
8	V Piscium	1	47	29	+ 8	45·5	..	6	9	Argelander	1863.
9	R Arietis	2	8	42	+24	26·8	186	8	12 <	Argelander	1855.
10	o Ceti	2	12	19	− 3	33·9	331·336	2	12 <	D. Fabricius	1596.
11	ρ Persei	2	56	50	+38	20·1	33	4		Schmidt.	
12	β Persei	2	59	41	+40	27·2	2·86727	2·5	4	Montanari	1669.
13	R Persei	3	21	47	+35	13·2	..	9	13 <	Winnecke.	
14	λ Tauri	3	53	35	+12	7·3	3·952	4	4·5	Baxendell	1848.
15	U Tauri	4	14	15	+19	30·5	..	9	10·4	Baxendell	1862.
16	T Tauri	4	14	25	+19	13·5	..	9.7	13·5<	Hind.	
17	R Tauri	4	21	11	+ 9	52·4	327	8	13·5<	Hind	1849.
18	S Tauri	4	22	5	+ 9	39·4	375	10	13 <	Oudemans.	
19	R Orionis	4	48	7	+ 7	56·0	378	9	12·5<	Hind	1848.
20	ε Aurigæ	4	53	38	+43	37·7	350±	3·5	4·5	Heis	1846.
21	R Leporis	4	53	14	−15	1·0	..	7		Schmidt	1855.
22	R Aurigæ	5	6	48	+53	26·2	..		..	Argelander.	
23	α Orionis	5	48	8	+ 7	22·8	196±	1	1·5	J. Herschel	1836.
24	α Argûs	6	21	4	−52	37·5					
25	R Monocerotis	6	32	4	+ 8	52·5	..	10	13	Schmidt.	

No.	Star.	R. A. 1870. h.	m.	s.	Decl. 1870. °	'	Period. days.	Change of Magnitude. From	to	Discoverer.	
26	ζ Geminorum	6	56	24	+20	45·0	10·16	3·8	4·5	Schmidt	1847.
27	R Geminorum	6	59	32	+22	54·2	370	7·3	11	Hind	1848.
28	R Canis Minoris	7	1	32	+10	13·2	367±	8	10	Argelander	1854.
29	S Canis Minoris	7	25	39	+ 8	35·8	335	8·5	11 <	Hind	1856.
30	S Geminorum	7	35	14	+23	45·7	294·07	9·2	13·5<	Hind	1848.
31	T Geminorum	7	41	29	+24	3·6	288·64	9·5	13·5	Hind	1848.
32	U Geminorum	7	47	23	+22	20·6	97	9	13·5<	Hind	1848.
33	R Cancri	8	9	29	+12	5·2	357	6	10 <	Schwerd	1829.
34	U Cancri	8	28	19	+19	21·0	306	9	13·5<	Chacornac.	
35	S Cancri	8	36	11	+19	30·1	9·48	8	10·5	Hind	1848.
36	S Hydræ	8	46	47	+ 3	33·8	256	8·5	13·5	Hind	1848.
37	T Hydræ	8	49	20	− 8	39·2	292 or 326±	6·5	10·5	Hind	1851.
38	T Cancri	8	49	25	+20	20·8	455±	9·5	12	Hind	1850.
39	α Hydræ	9	21	11	− 8	5·6	55	2·5	3	J. Herschel	1837.
40	R Leonis	9	40	34	+12	1·9	312·57	5	11·5	Koch	1782.
41	R Ursæ Majoris	10	35	25	+69	27·5	301·90	7	13	Pogson	1853.
42	η Argûs	10	40	1	−58	59·1	46 years	1	4	Burchell	1827.
43	α Ursæ Majoris	10	55	42	+62	27·1	sme. yrs.	15	2	Lalande	1786.
44	S Leonis	11	4	7	+ 9	9·8	192	9	13 <	Chacornac.	
45	R Comæ Berenicis	11	57	34	+19	30·7	1 yr.±	8	13 <	Schönfeld	1856.
46	T Virginis	12	7	56	− 5	18·3	337	8	13 <	Boguslawski.	
47	21 Virginis	12	27	4	− 8	44·1	..	5·5			
48	T Ursæ Majoris	12	30	29	+60	12·7	257	6·7	13 <	Argelander.	
49	R Virginis	12	31	54	+ 7	42·7	146	6·5	11 <	Harding	1809.
50	S Ursæ Majoris	12	38	14	+61	48·3	222·6	7·5	12	Pogson	1853.
51	U Virginis	12	44	30	+ 6	15·7	212	7·5	12 <	Harding.	
52	V Virginis	13	21	7	− 2	31·1	252	7		Goldschmidt	1857.
53	R (ν) Hydræ	13	22	36	−22	36·4	449·5	4	10 <	J. P. Maraldi	1704.
54	W Virginis	13	23	39	− 8	56·1	..	8·5		Hind.	
55	S Virginis	13	26	13	− 6	31·1	380·11	6	11	Hind	1852.
56	η Ursæ Majoris	13	42	24	+49	57·8	sme. yrs.	1·5	2	Lalande	1786.
57	X Virginis	13	47	39	11	48·0	..	8·5		Hind.	
58	T Boötis	14	7	59	+19	40·2	..	9·7	14 <	Baxendell	1860.
59	S Boötis	14	18	21	+54	25·3	..	8	12	Argelander	1860.
60	R Camelopardi	14	28	26	+84	25·3	265	7	13	Winnecke.	
61	R Boötis	14	31	27	+27	18·4	196	8	12	Argelander.	
62	U Boötis	14	34	48	+28	1·4	..	9·5	13	Baxendell	1864.
63	S Libræ	14	45	11	−11	47·5	..	8	9·5	Schumacher.	
64	T Libræ	14	49	33	− 3	49·5	..	8·5	10	Hind.	
65	β Ursæ Minoris	14	51	6	+74	40·5	2 or 3 y.	2	2·5	W. Struve	1838.

No.	Star.	R. A. 1870.			Decl. 1870.		Period.	Change of Magnitude.		Discoverer.	
		h.	m.	s.	°	′	days.	From	to		
66	S Serpentis	15	15	35	+14	46·8	359	8	10 <	Harding	1828.
67	S Coronæ	15	16	6	+31	50·8	..	6·5		Hencke	1860.
68	R Coronæ	15	43	13	+28	33·4	350	6·2	13 <	Pigott	1795.
69	R Serpentis	15	44	43	+15	32·1	352	6·5	10 <	Harding	1826.
70	R Libræ	15	46	13	−15	50·8	722	9	13·5<	Pogson	1858.
71	R Herculis	16	0	4	+18	43·3	310	8·5	13·5	Argelander.	
72	T Scorpii	16	9	17	−22	38·6	..	7	13 <	Auwers	1860.
73	R Scorpii	16	9	54	−22	36·6	648	9	14 <	Chacornac	1853.
74	S Scorpii	16	9	55	−22	34·6	364	9	13 <	Chacornac	1854.
75	U Scorpii	16	14	59	−17	34·5	..	9·5	13·5	Pogson	1863.
76	U Herculis	16	20	3	+19	10·6	..	7	13	Hencke	1860.
77	30 Herculis	16	24	22	+42	9·6	106	5	6	Baxendell	1857.
78	T Ophiuchi	16	26	18	−15	51·3	..	10·5	13 <	Pogson	1860.
79	S Ophiuchi	16	26	46	−16	53·3	229·3	9·3	13·5<	Pogson	1854.
80	S Herculis	16	45	59	+15	9·9	305	7·5	12·5	Schönfeld	1856.
81	Hind's Nova, 1848	16	52	13	−12	41·8	..	4·5	13·5<	Hind	1848.
82	R Ophiuchi	17	0	18	−15	54·9	304·6	8	13·5<	Pogson	1853.
83	α Herculis	17	8	42	+14	32·2	88·5	3·1	3·9	W. Herschel	1795.
84	T Herculis	18	4	10	+31	0·1	160	7·9	13 <	Argelander.	
85	T Serpentis	18	22	28	+ 6	12·3	310	10·5	14 <	Baxendell	1860.
86	κ Coronæ Australis	18	24	25	−38	50·2	years	3	6	Halley	1676.
87	R Scuti Sobieskii	18	40	32	− 5	49·4	71·75	5	9	Pigott	1795.
88	β Lyræ	18	45	15	+33	12·7	12·906	3·5	4·5	Goodricke	1784.
89	13 Lyræ	18	51	22	+47	46·7	46	4·2	4·6	Baxendell	1855.
90	R Aquilæ	19	0	7	+ 8	1·9	351·5	6·5		Argelander	1855.
91	T Sagittarii	19	8	43	−17	11·0	..	8·5	12 <	Pogson	1863.
92	R Sagittarii	19	9	3	−19	32·0	465	8	13 <	Pogson	1858.
93	S Sagittarii	19	11	49	−19	15·0	..	10·5		Pogson	1860.
94	R Cygni	19	33	20	+49	54·5	416·72	8	14 <	Pogson	1852.
95	11 Vulpeculæ	19	42	15	+26	59·4	..		..	Anthelm	1670.
96	Star in Vulpecula	19	43	3	+26	57·4	..	7	10	Rogerson	1837.
97	η Aquilæ	19	45	51	+ 0	40·4	7·1763	3·6	4·4	Pigott	1784.
98	χ Cygni	19	45	33	+32	34·5	406·06	5	13 <	G. Kirch	1687.
99	η Cygni	19	51	26	+34	44·3	mny. ys.	4·5	5·5	J. Herschel	1842.
100	S Cygni	20	2	46	+57	36·7	324	9	13 <	Argelander	1860.
101	T Aquilæ	20	5	39	+15	14·9	124±	8·9	11·3	Baxendell	1863.
102	R Capricorni	20	4	11	+14	41·1	..	9·5	13·5	Hind	1848.
103	R Sagittæ	20	8	7	+16	19·8	70·88	8·3	10·3	Baxendell	1859.
104	S Aquilæ	20	8	39	+ 8	41·7	..	9	12 <	Hencke	1851.
105	34 Cygni	20	12	59	+37	38·8	18y.±	3	6 <	Jansen	1600.

No.	Star.	R. A. 1870. h. m. s.	Decl. 1870. ° ′	Period. days.	Change of Magnitude. From	to	Discoverer.	
106	24 Cephei (Hev.)	20 24 48	+88 43·3	73 y. ±	5	11	Pogson	1856.
107	R Delphini	20 37 6	+16 37·1	284	8	11	Baxendell	1860.
108	S Delphini	20 39 19	+15 56·1	..	8·6	12	Baxendell	1863.
109	T Aquarii	20 39 54	− 5 49·9	197	7·8	0	Goldschmidt	1861.
110	U Capricorni	20 40 56	−15 15·8	420	11	13·5 <	Pogson	1857.
111	R Vulpeculæ	20 58 36	+23 18·3	147	8	13·5	Argelander.	
112	T Capricorni	21 14 46	−15 42·5	274	9	14 <	Hind	1854.
113	S Cephei	21 36 43	+78 2·7	470	8·9	11·12	Winnecke.	
114	μ Cephei	21 39 31	+58 11·1	5 or 6 y.	4	6	W. Herschel	1782.
115	S Pegasi	22 15 39	+ 7 22·0	..	8·5	13·5 <	Hind	1848.
116	Star in Aquarius	22 21 31	−10 39·0	..	8	0	Rumker.	
117	δ Cephei	22 24 20	+57 45·0	5·3664	3·7	4·8	Goodricke	1784.
118	S Aquarii	22 50 8	−21 1·8	..	8	11 <	Argelander	1853.
119	β Pegasi	22 57 27	+27 22·6	31·5 or 43·4	2	2·5	Schmidt	1848.
120	R Pegasi	23 0 7	+ 9 49·1	378	8·5	13·5	Hind	1848.
121	T Cephei	23 14 43	+55 19·9	..	8·2	8·8	Argelander	1863.
122	R Aquarii	23 37 46	−15 59·7	354 or 388·5	7	10 <	Harding	1810.
123	R Cassiopeiæ	23 51 49	+50 39·9	434·81	6	14 <	Pogson	1853.

Curious Old Equatoreal.—In the Astronomer Royal's Report for 1864, is the following:—"One old instrument has, since the year 1835, at least, borne the repute of being one of Flamsteed's. On carefully examining it we find that it is a perfect small equatoreal of the German form, with a steel polar axis, conical hole in the lower end for bearing on a conical pin, and brass ring near the upper end for bearing in a Y; above which are its telescope and declination circle on one side. The oldest equatoreal with which I am acquainted is Flamsteed's equatoreal sextant, of which we have an accurate drawing in a very rare engraving; its mounting was of the German form. From the style of workmanship as well as the general form, and from the circumstance that all Flamsteed's instruments are reported to have been taken away from the Observatory, I am inclined to believe that this old equatoreal is of Halley's time. Besides the coarse graduation on a small circle, by which the position of its declination frame was registered, it has a better graduation by which the position *of the telescope* on the declination frame was registered, and by which small differences of declination could be measured.

ASTRONOMICAL OCCURRENCES FOR AUGUST 1864.

DATE.		h. m.	Principal Occurrences.	Jupiter's Satellites.	h. m. s.	Meridian Passage. h. m.
						Altair.
Mon	1		Sidereal Time at Mean Noon, 8 41 23·1	1st Tr. I. „ Sh I. „ Tr. E.	8 31 9 47 10 44	11 1·0
Tues	2	2 34 16 18	● New Moon Conjunction of Moon and Venus, 6° 34′ N.	1st Ec. R.	9 13 58	10 57·1
Wed	3	21 46 23 16	Conjunction of Moon and Mercury, 6° 19′ N. Conjunction of Mercury and Regulus, 8m·0 W.			10 53·2
Thur	4					10 49·2
Fri	5			3rd Tr. I. „ Tr. E.	8 4 10 24	10 45·3
Sat	6					10 41·3
Sun	7	14 21 17 41	Conjunction of Moon and Saturn, 5° 6′ N. Conjunction of Mercury and ρ Leonis 6m·5 W.	2nd Oc. D.	9 39	10 37·4
						Moon
Mon	8		Declination of *Altair* + 8° 31′ 2″·5	1st Tr. I.	10 25	4 11·5
Tues	9			1st Oc. D. 2nd Sh. E.	7 41 9 27	4 57·2
Wed	10	5 57 7 8	☽ Moon's First Quarter Conjunction of Moon and Jupiter, 0° 22′ N.	1st Sh. E.	8 24	5 45·5
Thur	11	5 42	Near approach of Moon to β^1 Scorpii (2)			6 36·9
Fri	12					7 31·5
Sat	13	12 20 12 44	Occultation, disappearance of 16 Sagittarii (6) Near approach of Moon to 15 Sagittarii (5)			8 28·6
Sun	14					9 27·2
Mon	15					10 26·2

DATE.		h. m.	Principal Occurrences.	Jupiter's Satellites.	h. m. s.	Meridian Passage. h. m.
						Moon.
Tues	16		Sidereal Time at Mean Noon, 9 40 31·4	3rd Ec. D. 2nd Tr. E. 3rd Ec. R. 1st Oc. D. 2nd Sh. I.	7 28 9 9 26 9 26 28 9 37 9 40	11 24·5
						Altair.
Wed	17	1 36	○ Full Moon	1st Sh. I. „ Tr. E.	8 7 9 3	9 58·1
Thur	18		Declination of *Altair*, 8° 31′ 3″ 8	1st Ec. R.	7 32 8	9 54·2
Fri	19					9 50·2
Sat	20	10 10	Near approach of Moon to ε Piscium (4)			9 46·3
Sun	21					9 42·4
Mon	22					9 38·4
Tues	23	13 53 18 4	Conjunction of Moon and Mars, 0° 8′ S. ☾ Moon's Last Quarter	3rd Oc. R.	8 33	9 34·5
Wed	24			1st Tr. I.	8 47	9 30·6
Thur	25	22 6	Conjunction of Moon and Uranus, 3° 51′ N.	2nd Ec. R. 1st Ec. R.	9 11 10 9 26 52	9 26·6
Fri	26					9 22·7
Sat	27	22 22	Greatest Easterly Elongation of Mercury, 27° 9′			9 18·8
Sun	28		Declination of *Altair*, 8° 31′ 5″·0			9 14·8
Mon	29					9 10·9
Tues	30					9 7·0
Wed	31					9 3·2

TABLE OF NEBULÆ.

Right Ascension, Seventeen Hours.

NAME OF NEBULA.	Right Ascension.	Declination.
9 M. Ophiuchi	17 11 10	−18 22½
A beautiful nebula, very bright, and condensing rapidly towards the centre; the outline somewhat irregular.		
92 M. Herculis	17 13 0	+43 16½
A magnificent object, blazing towards the centre, and *just* resolved.		
14 M. Ophiuchi	17 30 30	− 3 10
A fine large globular object, the light rather diffused.		
37 Hersch. iv. Draconis ...	17 58 38	+66 38
A singularly brilliant planetary nebula.		

The four nebulæ in our list are all of them objects of great beauty and interest. 9 M. Ophiuchi will reveal to the attentive gaze of the observer its brilliant nucleus, its evidences of resolvability, and its straggling outliers; these last will best be glimpsed by the partially-averted eye. 92 M. Herculis is also worthy of the most careful examination; it is a splendid object. 14 M. Ophiuchi shows much less central condensation than the two preceding objects, the light being more equally diffused over it; the signs of resolvability are also much fainter. 37 Hersch. iv. Draconis is a wonderful object, its remarkable brilliancy giving it the aspect of a tiny Jupiter. It bears any magnifying power with but small loss of light. It is noteworthy that this nebula is situated in the Pole of the Ecliptic.

THE PLANETS FOR AUGUST.

Mercury passes from Leo to Virgo during August, and as the planet passes the meridian an hour or an hour and a half after the sun during the month, will be favourably fixed for observation in the evenings. It is at its greatest distance from the sun on the 23rd. It sets in the evenings on the 1st at half-past 8, and on the 31st at a quarter past 7.

1st R.A.	9	49	44	Dec. N.	14	39	Diameter	$5''\cdot4$
31st „	12	14	46	„ S.	4	34½	„	$7''\cdot4$

Venus is far too close to the sun to be observed unless with great trouble, and many precautions against glare. It sets about 8 o'clock in the evening on the 1st, and about a quarter past 7 on the 31st.

1st R.A.	9	4	33	Dec. N.	18	3	Diameter	$9''\cdot6$
31st „	11	26	45	„	5	3½	„	$9''\cdot8$

Illuminated portion of the disc of Venus=0·991.

Mars is now becoming the most interesting planet for observation, rising about 11 o'clock in the evening on the 1st, and about half-past 9 on the last day of the month. It passes from Aries to Taurus, and about 2 o'clock in the morning of the 24th is only 8′ south of the moon.

1st	R.A. 2 54 51	Dec. N. 14 47	Diameter 8″·4
31st	„ 4 4 32	„ 19 17½	„ 9″·8

Illuminated portion of the disc of Mars=0·846.

Jupiter may still be seen in the evenings, but is getting unfavourably placed for observation, both from its low altitude and the twilight. It is still in the constellation Libra.

1st	R.A. 15 3 56	Dec. S. 16 24½	Diameter 36″·2
31st	„ 15 14 53	„ 17 15½	„ 33″·2

Saturn has almost disappeared from view.

1st	R.A. 12 52 24	Dec. S. 3 2
31st	„ 13 2 21	„ 4 9½

Uranus rises about 1 o'clock in the morning at the beginning of August, and about 11 o'clock in the evening at the end of the month, passing from Taurus into Gemini.

4th	R.A. 5 51 16	Dec. N. 23 36
28th	„ 5 55 23	„ 23 37

Neptune may now be seen in the evenings, but will be better fixed for observation during next month and October.

4th	R.A. 0 32 32	Dec. N. 1 52
28th	„ 0 30 59	„ 1 41

THE MINOR PLANETS.

The following are the Minor Planets which will be on, or within one hour of Right Ascension, on either side of the Meridian, between nine and twelve o'clock during the evenings of August. Their places are to be found in the Supplement to the *Nautical Almanac* for 1867.

	Magnitude.		Magnitude.
Pallas	9·1	Euphrosyne	12·6
Astræa	10·9	Atalanta	12·2
Victoria	8·2	Isis	9·1
Irene	10·1	Ariadne	9·2
Eunomia	9·0	Calypso	12·1
Psyche	9·8	Mnemosyne	11·0
Thalia	11·6	Olympia	11·0

Les Mondes.—In addition to the printed record of the progress of science, so successfully and usefully provided by the Abbé Moigno in this publication, he has commenced a monthly *vivâ voce* account of the work accomplished—*cours de science vulgarisée*, which has met with the greatest success. The first *séance* was held on the 9th June, and the room was so full that another and larger one is to be used at the next meeting.—*Reader.*

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EQUATORIAL STAND WANTED, adapted for a 5-foot refractor, with graduated circles, second-hand, at a moderate price. [35]

CORRESPONDENTS' QUERIES.

G. K.—I should be glad to learn that you were making way with your monthly. *Personally,* I should be glad to see in it a little more account of work done, &c. &c., instead of extraordinary lucubrations on lunar rotation, "et hoc genus omne." But then I daresay these lucubrations possess a charm for some persons, so one must not grumble!

W. R. B.—Cannot Mr. Nasmyth give you an article on the *quiescence* of the moon during myriads of ages? He said much on the subject at the President's soirée.

G. J. J.—I am sorry to say that I have been able to do little in procuring you subscribers; the great tendency of the people seems to be to buy any kind of trash, which can be sold to almost any amount; witness Moore's, Zadkiel's, and other almanacs, &c.

Q.—Will any of your more learned readers kindly give the proper way of spelling equator*e*al and meridi*o*nal? It is as often spelt equator*i*al and meridi*a*nal as in the above manner.

W. L. B.—I look forward to some paper on Mr. Hopkins' newly-raised question on the sun's diameter, a matter of infinitely greater consequence than the foolish controversy about the moon's rotation, as involving the question also of the ellipticity of our orbit, a fact assumed as undoubted hitherto. But if we go on thus with the sun and moon we shall have to construct a new system of astronomy, and consign Newton to Ptolemy.

TO CORRESPONDENTS.

N.B.—Articles received after the 20th of the month cannot be inserted unless containing notices of fresh discoveries, or otherwise of immediate interest.

The following communications are unavoidably postponed until next month: "Nauticus," "Rev. W. R. Dawes," "Rev. N. S. Godfrey," "H." "W." and some others.

Received—Maury's *Physical Geography*.

X.—We beg to assure our correspondent that the letters against the insertion of which he protests, have not taken the space of other practical matter. We at all times give precedence to communications containing facts or observations connected with practical astronomy, over letters of a controversial or theoretical nature. We would print the letter of X, as sent to us, but that it would give rise to replies scarcely tending to the object of the *Register*.

N.B.—As it is intended, if possible, to publish the 21st Number of the 'Register' about the middle of August, it will be a great convenience to the Editor if communications are sent in by the 10th of the month.

LIST OF SUBSCRIBERS.

NAMES RECEIVED SINCE OUR LAST NUMBER.

Godfrey, Rev. N. S., M.A., St. Bartholomew's Parsonage, Southsea.
Maclear, Sir Thomas, F.R.S., Astronomer Royal, Cape of Good Hope.
Southern, William, Esq., 18, Lower Parade, Leamington.

ASTRONOMICAL REGISTER.—*Subscriptions received for the year* 1864—the Editor's list.

To June.
Frost, W.
Webb, Rev. T. W.
Huggins, W.
Kincaid, S. B.

To September.
Jefferies, J.
Johnson, R. C.
Bird, F.
Sargent, Rev. J. P.
Birt, W. R.

To December.
Welch, J. P.
Bazley, T. S.

July 28, 1864.

CONTENTS.

The Astronomical Register.

No. 21. SEPTEMBER. 1864.

ON THE VISIBILITY OF OBJECTS NEAR THE SUN.

By The Rev. W. R. Dawes.

In No. 20 of the *Register* is a paragraph headed "Superior Conjunction of Venus," and containing an extract from a letter of Mr. W. L. Banks, of Ealing, respecting the visibility of Venus near her superior conjunction. Perhaps he may have followed up the planet quite to the conjunction; and if in doing so he should have used the proper precautions, he will, I think, have been surprised to find how very close to the edge of the sun Venus is visible. There seems good reason to believe that few observers are aware of the power of telescopes over celestial objects in daylight, for I have occasionally related instances of it occurring in my own observatory, which have been received with such strong expression of wonder, as plainly revealed how much some zealous observers have to learn in an interesting department of telescopic observation. I have so often followed Venus quite up to conjunction with the sun, and within so small a distance of the limb, that I should have expected to see her easily at the late conjunction, when she was at the comparatively large distance of 38′ 8″ from the sun's northern edge. The day was cloudy here, but it might otherwise have been easily seen with almost any aperture.

The precautions to be employed in such observations are very simple and easily applied. The most important consists in using *a very small field of view.* With my solar eye-piece the diaphragm plate affords sufficient variety; but where this is not at hand, an efficient and very cheap substitute is found in a diaphragm cut out of a highly-glazed visiting card, and fitted into an ordinary eye-piece of moderate power. In the centre burn a very small hole with a red-hot needle. Such a diaphragm, with the glazed surface turned towards the sun, will bear its heat, with even a large aperture, for a considerable time. Then, Venus being supposed near her superior conjunction (*i. e.* within a few days of it), bring her into the middle of the field of any convenient eye-piece, and exchange it for the one furnished with the card-diaphragm. Great relief will immediately be felt from the glare of the sky by the intervention of this diaphragm, and Venus will appear proportionately brighter. Apply to the eye-piece as dark a shade as will permit the planet to be pretty easily distinguished in the middle of the small field of view; and with this same shade try how near to the north or south edge of the sun the eye can well bear the light. Read off the declination circle, and, having applied a darker shade, bring the edge of the sun into the middle of the small field. Read the declination circle again, and the difference of the readings will show how near the sun's edge the planet may be observed.

Soon after the recent conjunction I thus found that, if Venus had passed within one minute of arc of the sun's edge, I could have comfortably observed her with the whole aperture of my 8¼-inch object-glass—the aperture in the diaphragm subtending less than two minutes, and the sun's edge being only just excluded by the edge of the diaphragm.

Hopefield Observatory, Haddenham, Bucks:
August 9th, 1864.

Lumière Cendrée.—"I never, not even in nights among the high Alps, saw so beautiful an appearance of the moon. It was in the thinnest possible crescent, but the reflected light upon the remainder of its surface was almost as bright as the full illumination presented in less transparent skies."—*Hinchliff's South American Sketches.*

CORRESPONDENCE.

N.B.—We do not hold ourselves answerable for any opinions expressed by our correspondents.

FOUCAULT'S PENDULUM EXPERIMENT FOR SHOWING THE DIURNAL MOTION.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—In reply to your correspondent, "T. W.," in last number of the *Register*, I send particulars of the method for showing this beautiful experiment.

The hooks from which the pendulum ball is suspended must be very firmly screwed into a solid beam, which must have no tremor, and be not less than 45 feet from the floor.

The line of oscillation ought to be not less than 28 feet; the room, therefore, must be at least 36 feet wide.

The "suspender" is made in the following manner:—36 feet of steel wire, looped at each end; then 5 feet of silver harp string looped into the steel wire, and lastly, 4 loops, each 6 inches long, of silver harp string, looped within each other like a chain, to be looped to the 5 feet silver harp string; the other end loop of the chain is then to be hung over the hook in the beam, and the "suspender" is complete, the steel wire hanging nearly to the floor. If these directions are minutely attended to there will be no "torsion."

The cast-iron pendulum ball, somewhat pear-shaped, should weigh about 30 lbs., and be most truly turned in a lathe, with a ring at one end to suspend it by, and an iron point, about 2 inches long, at the other end, which must be set into the ball perfectly perpendicular.

As the entire success of the experiment depends upon the "*point*" being perpendicular, which is difficult to be attained by the fixed iron point alone, it is rendered easier by sticking on the "point" a small wine cork, having a needle projecting from it about 1½ inch, so that when the ball is suspended, the needle shall point truly perpendicular.

The pendulum ball should now be suspended from the bottom loop of the steel wire, by means of an S hook, which gives every facility for taking the ball on and off.

The perpendicularity of the needle can now be tested in the following manner:—first, allow the ball to come to a state of repose, then put on a board a stratum of damp sand, about an inch deep and evenly flattened, then, from below the needle, raise up the stratum of sand with the board, till the point of the needle is buried in the sand about 2-8ths of an inch; cautiously wedge up the board, and *without oscillation*, give the ball a circular motion. If the needle is perpendicular, it will revolve in the sand without making an irregular hole;

if otherwise, by slightly shifting the cork, the needle can be set perfectly true.

The needle being perpendicular, make a mark on the floor exactly under the needle, and strike a chalk-line through the mark, in the line of *proposed* oscillation across the floor, continuing the line about 6 feet up the wall on one side of the room.

Then strike three chalk-lines, each about 3 feet long, crossing the long line at right angles, and parallel to each other, one to be placed exactly under the needle point, and the other two to be 12 feet from the point, on either side.

The suspended ball must now be carefully brought to the upright line on the wall, and at the place where it touches a hook must be driven in.

The ball being brought back to the centre, get three boards, each 15 inches long by 9 inches wide; upon each of the boards strike a chalk-line, dividing them lengthwise; upon these lines place on each board a ridge of damp sand.

The ridges of sand are best cast in V-shaped tin moulds, about 8 inches long and 3½ inches deep; if the mould is filled with wet sand, and the board be placed on the top, on turning the board and mould over the sand will fall out, leaving a clear sharp edge.

It is very important to get clear edges to show the gradual passage of the needle; if, therefore, the sand ridges are imperfect, they can easily be recast.

The boards having the sand upon them should now be placed as follows:—one exactly under the needle, at right angles to the line of oscillation, and the other two on the parallel lines, 12 feet on either side.

To get the height of the two side ridges, the pendulum ball must be drawn by an assistant on either side, and the ridges of sand and boards raised till the needle in its passage makes a clean cut.

The centre ridge should also be raised in the same manner.

As soon as the ridges are adjusted, the chalk-lines on the boards agreeing with the chalk-lines on the floor, remove the three boards, and draw the pendulum ball up to the hook fastened into the wall; then make a loop of silk thread, about 6 inches long, pass one end over the S-hook by which the ball is suspended to the loop of the steel wire, and the other end over the hook in the wall, the ball will then be ready for the first oscillation.

The three ridges of sand must now be placed in their exact places, and a lighted lucifer-match being applied to the silk loop, the ball is liberated, the needle making a clean cut through each ridge of sand. On the return oscillation the needle will go exactly through the cut in the middle ridge of sand, and supposing the line of oscillation is from N to S, the needle will take off about 1-8th of an inch of sand from the S ridge towards the W.

In the next oscillation, the needle will still go exactly through the middle cut in the centre ridge, but will take off 1-8th of an inch of of sand from the N ridge towards the E.

In this manner the two side ridges of sand are gradually worn away by each oscillation, the needle passing and repassing exactly through the first cut in the centre ridge every time, thus showing that the

pendulum ball moves backwards and forwards in a straight line, while the wearing away of the sand at the S ridge towards the W, and the wearing away of the N ridge towards the E, demonstrates the fact that the cause is the "*diurnal rotation.*"

After about eight oscillations, the needle will cease to reach the outer ridges of sand, which can then be recast, the ball suspended by the silk thread loop, and the experiment repeated.

On reading the above description it will be obvious that only *one* ridge of sand is necessary to show the diurnal motion, whereas I have ordered three ridges. My reason for doing so is, that with one ridge at N and one at S, two sets of spectators may watch the motion. The middle ridge is ordered to test the experiment itself.

It has been asserted *that the motion* of the ball is not straight, but elliptic; consequently at every oscillation the ball describing an ellipsis the needle would advance, cutting the sand away, not because of the "diurnal rotation," but because of the elliptic motion.

The single cut in the middle ridge of sand shows that this is not the case; for if the ball described an ellipsis there would be *two cuts* in the middle sand ridge, which is not the case if the experiment be well conducted.

I cannot conclude without alluding to the impressive sight which the pendulum ball gives when it commences its "stately march." I had the great pleasure, in 1854, to see Foucault's original experiment, when the ball was suspended from the dome of the Pantheon at Paris; an experiment, the discovery of which was as original, and almost as important, as that of Torricelli, when he found out the barometer.

I have often thought if the authorities would allow the experiment to be tried under the dome of St. Paul's Cathedral, what a magnificent sight it would be to see the ball rushing along its superb curve 200 feet long with the speed of an express train, the needle cutting its way into the sand many inches before the oscillations ceased to reach it.

The Cathedral authorities would deserve the thanks of all who take an interest in popular education, if they would have this grand experiment permanently exhibited, which might be done at a cost of three or four pounds.

I am, Sir, yours respectfully,

69 Worcester Street, Birmingham: ALFRED BIRD.
August 9, 1864.

THE SUN'S DIAMETER.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—Controversy, and bold attacks upon ancient, and, as we were long wont to suppose, incontrovertible dogmata, seem quite the order of the day; and truly the pages of the *Astronomical Register* do not seem to be desirous of checking the spirit of free inquiry and free discussion. Within certain limits we must all admit the justness

and wholesomeness of such a spirit. But still, "too much of a good thing" may degenerate into a "bad thing." This sentiment, I apprehend, has established itself as a proverbial axiom amongst us.

The foregoing remarks have been elicited in consequence of certain statements from the pen of Mr. E. Hopkins, C.E., in the June and July numbers of the *Astronomical Register* for the current year, wherein he makes the startling announcements following:—First (See No. for June, page 134), that "The sun appears less in December than in June to the inhabitants of the southern hemisphere." Secondly, that "The sun, when measured in the zenith within the tropics, appears the same size all the year round;" and, Thirdly, that "At an altitude of about 22° the sun's diameter is at all times of the year, and in both hemispheres, 32′ 32″"—corrected in the July number of the *Register* to 32′ 22″.

All these statements, endorsed in some sort, as it would appear from Mr. Hopkins's paper, by his friend Sir E. Belcher (see July *Register*), are backed up by a tolerably formidable list of observations, "obtained" (though Mr. Hopkins does not distinctly say by whom) "by means of a good sextant and a repeating circle, and carried on for upwards of ten years near the equator."

But as regards his own observations, apparently, Mr. Hopkins presently goes on to state—"Again, at Melbourne, latitude 38° south, I obtained the following results:—

		°	′		′	″	
June . . .	∠	28	22	. .	32	20	diameter.
Sept. . . .		52	0	. .	31	40	"
Dec. . . .		75	27	. .	31	0	"

"Hence," says Mr. Hopkins, "it follows that the ellipticity of the earth's orbit" . . . and the "supposed variable velocities" of the earth in that orbit, are "founded on an optical illusion;" and, in consequence, that the measurements he has adduced, in connexion with the laws, as he says, of atmospheric refraction, "affect and vitiate many of what have hitherto been regarded as fundamental data of physical astronomy."

By laws of atmospheric refraction, indeed! Well, Mr. Editor, though not deeply versed in the *laws* of atmospheric refraction, yet the following counter-statements, founded upon most carefully measured *phenomena* and *effects* of atmospheric refraction, may not be unacceptable to many of your readers, and may possibly help them to rest as well satisfied as I am of the truth of the "fundamental data," verily, of physical astronomy, as held by the Keplers, Herschels, Airys, Leverriers, Adamses, and others of the most illustrious champions of mathematical and physical astronomy.

One, moreover, of the goodly list above enumerated, upon being asked by me whether he had ever happened to have measured the sun's apparent diameter at different seasons in the southern hemisphere, replied, "No! I never took the trouble, and I wonder you should."

But as the *Astronomical Register* is intended for the multitude, permit me (as one from amongst themselves) to state what I have myself recently observed by the aid of a telescope of 4-in. aperture,

equatorially mounted, the property of the R.A.S., furnished with simple but trustworthy micrometric apparatus of my own, and which I had hauled up (expressly for the purpose of testing Mr. Hopkins's statements) to the top of my church-tower; from whence, at an elevation of about 500 feet above the sea, an uninterrupted view of the horizon is obtained in almost every point.

The following were the results I obtained on two different days, viz. July 6th and July 14th, 1864, and which were only corroborations of facts with which I had been familiar, by personal experience for the last five years, during which I have kept a record of the condition of the solar disc. It will be seen that my measurements are in excess somewhat of those given in the *Nautical Almanack*, and so far doubtless am I in error. But I was resolved to be on the safe side.

At and after sun-rising, July 6, 1864 G. M. T.	Approximate apparent elevation of sun above the horizon	Approximate apparent diameters of sun in measurements of arc	
		Vert. Diam. (increasing till an elevation of about 12°)	Horizont. Diam. (always constant, or very nearly)
h m	° ′	′ ″	′ ″
3 58 a.m.	0 40	29 13	31 40
4 8 "	2 30	29 34	Do.
4 25 "	5 30	30 16	Do.
4 35 "	6 30	30 59	Do.
4 50 "	8 30	31 20	Do.
5 5 "	11 0	31 41	Do.
5 15 "	12 30	Do.	Do.
6 0 "	19 30*	Do.*	Do.
Noon	63 ±	Do.!	Do.!

Thus the various degrees of the elevation of the sun above the horizon had no effect whatever upon his apparent *horizontal* diameter; whilst on the other hand, in distinct contravention of Mr. Hopkins's statements, the sun's apparent vertical diameter was actually *diminished* in proportion as the sun was nearer to the horizon! the difference, in fact, on the morning of July 6th, 1864, being no less than 2′ 27″ between the hours of 3h 58m and 5h 5m A.M.

On July 14th, at about sun-setting, the same results, only still more striking (and reversed, of course) were obtained by me; and yet Mr. Hopkins strangely omits to tell us whether, in his statements, he alludes to the apparent vertical or horizontal diameters of the sun at sun-rising, at page 166 of your July *Register*.

* Mr. Hopkins says that the sun's diameter at about this elevation (or at least at 22°) should be 32′ 22″! and which no doubt it will be, when at the same elevation in December next.

Before and about sun-setting, July 14, 1864 Approximate G. M. T.	Approximate apparent elevation of sun above the horizon	Approximate Apparent diameters of sun	
		Vert. Diam.	Horizont. Diam.
h m	° ′	′ ″	′ ″
6 54 p.m.	7 0	31 41	31 41
7 4 "	5 30	"	Do.
7 19 "	3 30	31 20	Do.
7 34 "	1 30	30 59	Do.
7 49 "	0 40	29 55	Do.
7 54 "	0 35	29 34	Do.
7 57 "	0 25	28 52	Do.
7 58 "	0 20	28 31	Do.
8 0 "	0 15	? Interfered with by distant trees.	Uncertain through rippling of margin

It is thus amusing to observe how (forgive the cruel pun) the statements of Mr. Hopkins are both *flatly* and *diametrically* gainsaid in the above tables!

I remain, Sir, yours faithfully,

FRED. HOWLETT, F.R.A.S.

St. Augustine's Parsonage, Hurst Green:
Aug. 8, 1864.

P.S.—When the earth is at *perihelion* (forgive me, Mr. Hopkins!) you shall, if all be well, hear from me again.

COMET I, 1864.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—It may interest some of your readers, who may not have seen the present comet, to hear a few observations of my own.

On the 1st the comet was a few degrees east of the Pleiades (R.A.= 58° 7′, Dec. N. 25° 2′ at midnight), and was rather a conspicuous object, being as bright as a 4th mag. star. In the telescope the diameter of the coma appeared about 6′, and was much brighter toward the centre, but I could see no star-like nucleus.

The tail, which was very faint (not having more than a sixth of the light of the head), was about 40′ long. The comet was passing over some small stars, one of the 10th mag. being in the coma, and a 9th mag. in the tail at 12h. 15m.

Aug. 2nd.—I again saw the comet at 1h. 15m. It was rather brighter to-night than it was yesterday. With great attention I

could make out a nucleus like an 8th mag. star, in the centre of the head, being almost lost in the blaze of light. The tail is still faint.

Aug. 3rd was cloudy.

Aug. 4th.—The night was very fine, and the comet brighter than I have yet seen it.

The nucleus was now very plainly seen, and there was a remarkable fan-like appendage proceeding from the nucleus away from the sun, somewhat resembling that in Comet II. 1862, but larger and broader and also less bright.

Its motion is now very rapid, being 7° per day; but this will increase as it nears its perihelion, which is on the 16th inst.

On the 6th inst., at midnight, it will be between Castor and Pollux, and will be nearest the earth on the 8th.

Apologising for trespassing on your space,

I am, Sir, yours obediently,

HERBERT INGALL.

Camberwell: Aug. 6, 1864.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—It would be pleasant to know what observations any of your readers may have made of the present comet, of whose proper name and designation I am ignorant.

My newspaper yesterday, August 3, gave us a communication from Mr. Chambers of Eastbourne, which directed my attention the same evening to the neighbourhood of the stranger. Giving for its R.A. 3.55.3 and Decl. + 25.18, I sought and found it, not there; but on sweeping with a low-power comet eye-piece, found it almost immediately in R.A. 4h. 10m., and Decl. N. 26° 35′, very near the wide double star ϕ Tauri, both that and the comet being in the field of the finder together.

The comet in my telescope, a 5-inch achromatic, by Cooke of York, had somewhat the appearance of what Admiral Smyth calls "an overpowering nebula," with a blazing condensation at the centre, and thinning outwards, not equally in all directions, to a gauzy transparency, through and near which many telescopic stars were visible, but no streaming coma in one direction.

The comet's appearance to the naked eye is that of a dull, blurred, and reddish star of the 4th mag., but in my telescope, with a power of 45, subtending an angle equal to the moon. It would seem, therefore, to be of vast dimensions, and also, comparatively, very near the earth.

Aug. 4.—An unfavourable night for observation, from frequent interruption of clouds and haze. I have obtained no view since.

I remain, yours faithfully,

R. J. GOULD.

Mortimer Vicarage, Reading:
Aug. 6, 1864.

THE SATELLITES OF SATURN.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—I heartily concur with your correspondent "S. B. K." in his desire that your valuable work should contain a table of the positions of Saturn's satellites, which to myself and several friends would be very useful. From what he adds, however, as to their transits and eclipses, he overlooks the difference on the apparent figure of their orbits compared with that presented by the satellites of Jupiter, which not only renders their tabulation more difficult, but precludes the visibility of their transits and eclipses, excepting when the ring is seen edgeways or nearly so.

The near coincidence of the plane of the orbits of Jupiter's satellites to the ecliptic renders the apparent ellipses they describe so narrow, that their latitudes may be disregarded. But those of Saturn, varying every seven years from a straight line to an ellipse, of which the breadth is nearly half the length, would obviously require that, to be useful in distinguishing the satellites from small stars, their positions *above* and *below* the primary, as well as to the east and west of it, should be exhibited.

The great elongation of Iapetus, 32 diameters of Saturn, his different inclination to the ring and position of ascending node, would also in the case of this satellite, of which it is most desirable to be able to ascertain the position by inspection, be obstacles to be surmounted in constructing a table.

I am not aware whether the transits of the shadows of the smaller satellites across Saturn have ever been observed even with powerful telescopes; but there is, in the Astronomical Notices for 1862, a very interesting paper by the Rev. W. R. Dawes, of his observation of the transit of the shadow of Titan on the 15th of April; and from his remark that it might possibly be seen with a $3\frac{1}{4}$ or 4-inch object-glass, I was led to observe the subsequent transit of June 2nd, and saw the shadow upon Saturn with a 44-inch refractor, $2\frac{7}{8}$ aperture, as easily as I have ever observed that of the first satellite of Jupiter with the same instrument.

Should you find the insertion of a requisite table incompatible with the space your pages allow, I shall be happy on a future occasion to describe a method which, with the help of a friend, I adopted many years ago, and which, without any pretension to mathematical accuracy, suffices, by the construction of a diagram each season, adapted to the varying ellipse of the satellites, and some ordinary arithmetical process, to obtain in a few minutes the position of any of them required.

I am, Sir, your obedient servant,

Ealing: Aug. 8th, 1864. W. L. BANKS.

[The Editor of this paper was fortunate enough to obtain an independent observation of the transit of the shadow of Titan on the same evening as Mr. Dawes, 15th April, 1862. With an aperture of $3\frac{3}{8}$ inches the shadow was beautifully distinct.—See *Monthly Notices*, vol. xxii. page 294.]

TERRESTRIAL AND ASTRONOMICAL THEORIES.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—It has been very justly observed, that the generality of persons take no trouble about the investigation of the *truths* of science, but prefer taking things for granted, and adopt what may be subscribed for them by those who are supposed to be the guardians of science.

This is one of the causes why so many fallacies have been propagated from one generation to another, uncorrected and unchecked.

A correspondent, signing "W. L. B.," refers to my letters on the "sun's diameter," and thinks that it is a "newly-raised question." I beg leave to inform him that the question is not new. I made numerous and careful observations from 1837 to 1842 near the equator, and published the results in 1843 in my work on "Geology and Magnetism," page 78, to which I beg reference. The observations have been since repeated in the southern hemisphere, and have been fully confirmed. I do not understand what your correspondent means in his remark that "we shall have to construct a new system of Astronomy, and consign Newton to Ptolemy."

The accepted *system* of astronomy is the Copernican. My observations merely restore that system into its original simple conditions of circular orbits and uniform motions, which were (through an optical illusion) contorted by Kepler into ellipses with variable velocities. Newton was neither an astronomer nor an observer, but a great mathematician, and he applied his powerful geometrical intellect to account for the observations of Kepler, which he took for granted were correct. The author of the present *modified* Copernican system was Kepler, and not Newton; therefore the remark of your correspondent is not applicable to the question at issue.

We have more to learn in matters connected with terrestrial physics and astronomical theories than is dreamt of in our philosophy, and it is much to be regretted that what can be seen, examined, demonstrated, and even handled, to arrive at the truth, are all but neglected for the sake of *speculating* on the composition and structure of the heavenly bodies, and other visionary matters beyond the grasp of human intellect.

I am, Sir, yours very faithfully,

EVAN HOPKINS, C.E., F.G.S., &c.

15 Clarendon Gardens, Aug. 8, 1864.

ON THE MOON'S ROTATION.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—When I wrote my former letter on the subject of the Moon's Rotation, which you did me the honour to publish, I had been looking in vain for a small pamphlet which was kindly presented to me

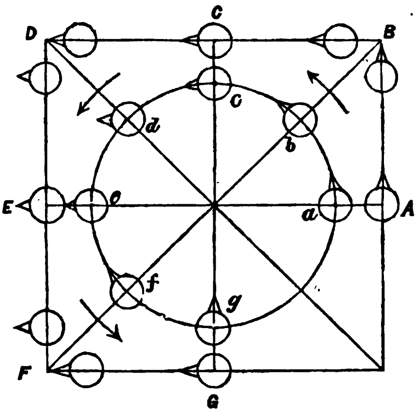
some years ago by its author, Mr. Henry Perigal, junior. It has since been found; its date is December 1856. On a second careful perusal of it, I fancy that I perceive the reason why thoughtful men of clear intellect differ so widely in their apprehensions of what seems to be a very simple affair. One or two brief quotations from that pamphlet will be sufficient to elucidate this point.

On page 15, in the second paragraph, the author says: "Supposing the sun were stationary in space without any other motion than a circular movement of rotation about its own centre, such axial rotation might be very properly referred to a line fixed in space. If the earth revolves round the sun, then such orbital revolution may be referred to the same fixed line. If the earth, while so revolving, has a second movement of rotation about its own centre of gravity, then such axial rotation should be referred to the line joining the centres of the earth and sun; not to the first-mentioned fixed line. Again, assuming the earth revolves about the sun, if the moon revolves about the earth, and simultaneously were to rotate upon her own centre of gravity, her orbital revolution about the earth ought to be referred to the line joining the centres of the earth and sun, while her axial rotation should be referred to the line joining her own centre to that of the earth." And towards the bottom of the same page is the commencement of a paragraph which seems to be intended as a summing up of the whole, and is marked with double commas as if it were a *quotation*, though from what author is not said. It reads thus: "A moving body which continually varies the angular position of its diameters and parts to its progressive line, or orbit, in so doing, rotates, or turns round an axis within itself. A moving body, which constantly keeps all its diameters and parts in the same angular position with regard to the line of its progress, or orbit, does not rotate, or turn on an axis within itself; and, thereby, in a circular progress, keeps always the same side to the centre of its orbit."

Herein is the gist of the whole controversy. The positive and *ex-cathedrâ* statement above quoted, is neither accompanied by any proof of its correctness, nor supported by any competent authority; and it appears to me to assume the form and occupy the position of a *false definition* of rotation. The simple fact that a body turns round on an axis within itself, is altogether independent of its being either stationary, or in motion in any particular direction or in any kind of path, whether it be a right line or a curve of any sort whatever. Let us again quote the same pamphlet, page 11: "If a body present successively every part of its surface to every point of the compass, it must turn round. Nobody, I think, will dispute the truth of this as an abstract proposition. All will agree in considering it an axiom." This is in fact all we want, and a truth which involves all we contend for. But the author goes on to say: "Not so, however, with the converse of the proposition, viz. that if a body turn round, it must present successively every part of its surface to every point of the compass." And then he proceeds to introduce his own peculiar fallacy, viz. that if a body revolves round another, and yet while doing so it presents the same parts of its surface to the same points of the compass, this can be effected only by its turning round, or rotating, simultaneously and with the same angular velocity *in the opposite*

direction to that of its revolution! And this extraordinary fallacy is supported by an exhibition of machinery, which, however ingenious, is far from correctly representing the facts of the case, as will be shown hereafter.

But as a picture presented to the eye greatly assists the apprehension of a verbal description, we will refer to the diagram in the margin. Let a body, denoted in its different positions by the capital letters A, B, &c. move on the lines forming a *square*; and another similar body, denoted by the small letters *a*, *b*, &c. move on a *circle* within the square, and, for distinctness' sake, at some distance from it; each body having a projecting *beak* to indicate one side of it. In the first quarter of the square the body at A moves forward to B, and at the angle performs a "left-face,' turning round through one quarter of a complete rotation on its internal axis; and thus it proceeds to C, with its beak at right angles to its first direction. At the same time the body at *a* proceeds along the circular arc to *b* and *c*, carrying its beak before it as it describes the arc. When both the bodies have arrived at C and *c*, it is found that their *beaks* are both looking in the same direction, and are also standing at right angles to the direction in which they started. Now the body on the *square* has evidently performed a rotation through an arc of 90°; how then can it be denied that the body on the circle has done the same?



Again, if the lines from C to D, and from D to E, are traversed without rotating at all, the beak at E will be found in the same direction as it was at C, the motion from D to E having been performed *sideways*; and if the quadrant from *c* to *e* be traversed without altering the direction of the beak, the body at *e* will be found looking in the same direction as it did at *c*, and also as the body at E. But the body at E has not rotated at all since its departure from C. On what ground, then, can it be asserted that the body at *e* (on the circle) *has rotated in the opposite direction*?

This may be still further exemplified in the third quadrant—the body on the square still not rotating at all; while that on the circle rotates through 90° in the direction *opposite* to that of its revolution.

Complaint has been repeatedly made that we bring forward no *proof* that our views of the moon's rotation are correct. On the contrary, it appears to me that abundant proof has been produced, which has never been answered, but passed over in silence; the oft-refuted fallacies being repeated as before. But I will now offer a proof of a *personal* kind. Let a man walk forward, and backward, and sideways,

towards the right and left, and, however rapidly he may do so, while keeping his face towards the same point of the compass, he will feel no giddiness, because he performs no rotation. Then let him, by a combination of these forward, sideway, and backward movements, move round some central object, such as a small round table, but still keeping his face in the same direction; and when his legs have got over the awkwardness of this combination, however rapidly he may thus revolve round the table, and however long he may continue to do so, he will find no giddiness; affording him internal evidence that though he revolves round a central body, and always faces the same point, he does *not* rotate in the opposite direction to that in which he revolves. Then, finally, let him walk round the table, keeping (say) the left shoulder towards the centre; and if he do this quickly, and for some minutes together, he will soon have internal evidence that he is *rotating* as well as *revolving*, in the giddiness it will be sure to occasion. Children may often be seen chasing one another in play round a table; but after a while obliged to sit down, perhaps fall; or to run round the other way to remove the giddiness they feel.

Such facts appear to me to be sufficient and unanswerable *proofs*; and that nothing offered on the other side of the question can properly be so considered, may be shown by an examination of the experiments and mechanical illustrations relied on. But as I have already trespassed largely on your valuable space, I will postpone this part of the subject to another opportunity.

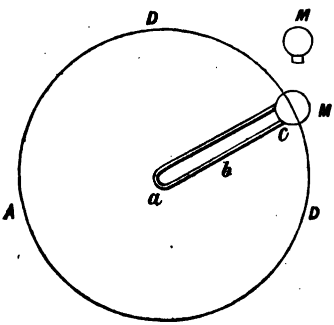
I remain, Sir, your obedient Servant,

W. R. DAWES.

Hopefield Observatory, Haddenham, Bucks:
July 18, 1864.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—If you do not consider that you have already devoted too much space to the discussion relative to the rotation of the moon, will you allow me to submit for your insertion a diagram, which, during the memorable contest on this subject some few years since, was by many persons considered as a simple and confirmatory illustration of this much contested rotation?



In the following observations we entirely dispense with the progressive motion round the earth's orbit, as its consideration is by no means necessary to our purpose.

In the above *mechanical* diagram, let A, D, D represent the orbit of the moon; and *a*, *b*, *c* a radius of the same, with a groove running down the middle of its entire length, which radius is to turn

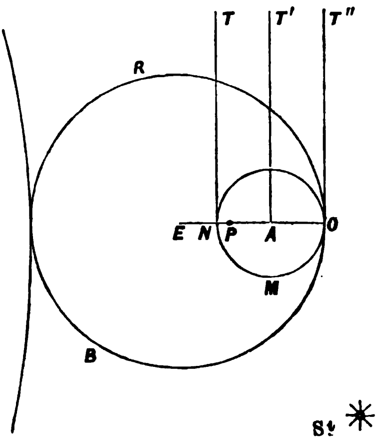
on the centre *a*, of the orbit. Let also the moon be represented by a ball, M, with a *tooth* at the bottom, in form of a die, exactly fitting the groove of the radius into which it is to be placed. Now, I suppose it will be admitted that, whatever the length of the radius may be, there will be no difference in the *kind* of motion shown by the ball when revolving with the radius. Therefore, on whatever part of the radius we slide this ball, by making the radius revolve with the ball in this position, the *kind* of motion will still be the same—that is, whether the ball be at *c*, or *b*. Now, let us slide the ball as near to the centre, *a*, as possible, and I think we shall find no appreciable difference from the required rotation on the axis of the ball. This seems to me to be a fair way of putting the question, and being devoid of mathematical calculations, may be understood by general readers.

I am, your obedient servant,

June 18, 1864. W.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—Assuming that a body can be properly said to rotate only when it turns about an axis within itself, I beg to submit the following considerations in support of the position that the moon does *not* rotate in her course about the earth and sun.



1. To clear the definition of rotation, let us ask what is meant by *turning about* an axis. Plainly, that points in opposite radii should move in contrary directions.

2. Let O R B be a wheel (centre E) rolling round the edge of a circular table of large dimensions, whose centre is S; M O N a disc of cardboard, *capable* of rotating about a centre A; the axes of disc wheel and table being all parallel to one another; and let St be some external point nearly in a plane with those of the table and the wheel.

Then S will correspond to the centre of the sun,
E " " " earth,
A " " " moon;

St may be a star in the ecliptic; and we shall have in M O N (which represents a section of the moon through her equator) a motion nearly analogous to that of the moon, our point of view being that of a person stationed at a vast distance from the solar system in the direction of either pole of the ecliptic.

(*a*) Now, if M O N *rotates* about A, any point P in the line A N must leave the line A E (unless E be itself also carried round about A, which is inadmissible). But in fact it does not leave it, except in slight libration.

(*b*) But let us take a more comprehensive view. We have to consider the motion of M O N by itself in space, as if it were disentangled from connection with the earth and sun, but retained its present motion; and the question is, does it rotate? I submit that it does not *rotate*, being whirled about a centre external to itself, that centre having its own path in space meanwhile.

The points N A O are at any given moment all moving *forward*, with different velocities, but *in the same direction* (are they not?)—a direction compounded of that of the tangents N T, O T″, and the parallel A T′, and that in which E is moving. And although A N will sometimes point to St, it will do so only when A E points to St: that is, it will be the result, not of the rotation of M O N, but of its circumvention about E.

I am, Sir, yours faithfully,
H.

MR. DE LA RUE'S SOIRÉE.

We here redeem our promise of recurring to the Meeting at Willis's Rooms, by giving a list of the articles exhibited, thinking it not only likely to be interesting to our readers, but desirable as preserving a record of an event of some little importance to the science of Astronomy.

ARTICLES EXHIBITED AT THE SOIRÉE

Of Warren De La Rue, Esq. F.R.S., President of the Royal Astronomical Society, at Willis's Rooms, June 11th, 1864.

The President.—Astronomical Photographs and Drawings of the Planets. Photograph of the Eclipse. Photograph of the Moon 38 inches in diameter.

A Collection of Turner's Paintings.

The Astronomer Royal.—Diagrams illustrating the Transit of Venus in 1882.

Model of a proposed mounting for a Telescope intended to follow the Moon, or a Planet, in its orbit.

The Earl of Rosse, F.R.S.—The Original Drawing of the Nebula of Orion.

The Astronomical Society.—Universal Instrument by Reichenbach and Ertel, presented to the Society by Admiral Greig. An Equatorial, constructed by James Smeaton, 1770. A Bronze Arabian Celestial Globe, with Stars, inlaid, of silver. A Quadrant, by Abraham Sharp. Original Drawing, by J. Hippisley, Esq. F.R.S., of the Nebula of Orion, from Observations by William Lassell, Esq. F.R.S.

J. Williams, Esq. Assist.-Sec.—A Telescope, date before 1700;

length about 14 feet, with the original object-glass and three-lens eye-piece. An Arabian Astrolabe, dated 1636, the five plates displayed. A smaller Astrolabe, date 1628. A Ring Dial, 1630. A Nocturnal. Chinese Compass. Napier's Bones. A Chinese Statue, with the Votive Offerings contained in it, about 1630. Photographs of Greek Coins. Volume of Electrotype Copies of Large Brass Roman Coins, &c.

KEW OBSERVATORY.

1. The Glasses and Original Mountings of Huygens' Aerial Telescope (120 feet focus).
2. Model of the Tower which Mr. De La Rue proposed erecting here in order to view Saturn through these Glasses.
3. An old Quadrant (diagonal scale), by Butterfield, Paris.
4. Boyle's Air Pump.
5. Sun Pictures.
6. Photo-lithographs of Magnetic Curves, taken simultaneously at Kew and Lisbon.

Nos. 1, 3, and 4 are the property of the Royal Society.

LONDON INSTITUTION.—A Newtonian Telescope by Sir William Herschel, and other Instruments selected by E. W. Brayley, Esq. F.R.S.

Professor PHILLIPS, F.R.S. *Oxford.*—A Series of Astronomical Drawings.

T. W. BURR, Esq. F.R.A.S.—A Series of Drawings and Diagrams of Observatories, Astronomical Instruments, Planets, Comets, &c.

J. NASMYTH, Esq.—Colossal Drawings of the Whole and Portions of the Lunar Surface. Model of a Portion of the Lunar Surface. Glass Globe split up by an Internal Force to Illustrate the Radial Markings in the Moon.

Rev. F. HOWLETT, F.R.A.S.—A Drawing of the Sun's Surface, 4 ft. 2 in. in Diameter, June 8, 1864, and Diagrams showing changes in the Spots from January 24 to February 1, 1864.

ALEX. S. HERSCHEL, Esq.— Meteorites and Model of Shooting Star, triply observed, at Cranford, Hawkhurst, and London.

Professor WHEATSTONE, F.R.S. D.C.L.—A Pair of Indicating Instruments. Magnetic Type-printing Telegraph.

C. W. SIEMENS, Esq. F.R.S.—A Differential Wind and Pressure Gauge.

E. W. COOKE, Esq. A.R.A. F.R.S.—Pictures of Venice. An old Roman Sun Dial.

A. MCCALLUM, Esq.—A Collection of Paintings.

OWEN JONES, Esq. V.P. Soc. Architects.—Paintings illustrating Architecture.

H. WARREN, Esq. Pres. of New Society of Painters in Water Colours.—Water-colour Drawing.

Messrs. LLOYD, BROTHERS.—A Collection of Modern Paintings.

HENRY SWANN, Esq.—Crystal Casket Photographs.

THOS. WOOLNER, Esq.—Four Bronzes of Animals—Lion, Lioness, Eagle, Camel.

MORTON EDWARDS, Esq.—Bust of H.R.H. the Prince of Wales.

To be continued.

Physical Geography, for schools and general readers, by M. F. Maury, L.L.D.—A very handy little book, in which a great deal is contained in a small compass, the subject being treated in a style not quite so dry as in many similar works of instruction. Its author is well known, not only as a commander in the Confederate States navy, but as a most lucid writer on all subjects connected with the ocean; his *Physical Geography of the Sea* and other works, written while he was in charge of the Washington Observatory, having a well-deserved reputation. The present work treats of the various influences which prevail on the surface of the globe; air and water, whether moving or still, whether acted on by heat or cold, their offices, and the effects produced by them, are explained; the object of the author being, as he states in the preface, so to present the principles upon which the science of physical geography is founded, that the reader may apply them to that of his own country. Engravings, illustrative of the direction of the prevailing winds and ocean currents, accompany the volume.

Large Refractors.—Alvan Clark's 18½-inch refractor, purchased for the Chicago Observatory, is to cost, including transportation and mounting, 18,187 dollars, and to be finished in June, or some time before the tower is ready for its reception. The tower is to be octagonal in shape, 35 feet in diameter, and 100 feet high to the hemispherical top. In reference to large telescopes, the following is from a correspondent's letter:—"What is doing with the great object-glass in process of grinding by the Messrs. Cooke? it was said to be the largest in existence. There was also a very large one shown at the 1862 Exhibition by Mr. Buckingham,—has it done anything? It seems to me that the best work emanates from moderate-sized glasses.—P. J."

Tycho Brahe's Temporary Star.—The *Astronomische Nachrichten* for July 14, contains an interesting paper, by Argelander, as to the identity of this star with some one of the stars now visible in Cassiopeia.

Sun Spots.—At page 185 of this volume we gave Dr. Schwabe's results for 1863. M. Wolf, of Zurich, has just published his for the same year. He observed the sun on 360 days, of which only on two were no spots seen. The relative number was 44·4, against 98·6 in 1860.

THE PLANETS FOR SEPTEMBER.

Mercury continues to be pretty well fixed for observation during the month of September, until it arrives at inferior conjunction on the 24th. It passes from Virgo to Leo. On the 1st, it sets about a quarter-past 7 in the evening.

1st	R.A. 12 17 27	Dec. S.	5 1½	Diameter	7″·6
30th	„ 11 43 35	„ N.	1 7	„	9″·0

Venus remains in the constellation Virgo during the month, but is still too near the sun to be favourably observed. It sets about a quarter-past 7 at the beginning of the month.

1st	R.A.	11	31	18	Dec. N.	4	33½	Diameter	9″·8
30th	„	13	42	53	„ S.	10	6	„	10″·4

Illuminated portion of the disc of Venus=0·961.

Mars, which remains in the constellation Taurus during the month, is now a very conspicuous object, rising in the North-east, about half-past 9 in the evening, on the first of the month, and shortly after 8 on the last day.

1st	R.A.	4	6	37	Dec. N.	19	24	Diameter	10″·0
30th	„	4	56	8	„	21	49	„	12″·2

Illuminated portion of the disc of Mars=0·864.

Jupiter and **Saturn** are now practically invisible.

Uranus rises in the evening about ten minutes before 11 on the 1st September, and is in the constellation Gemini.

1st	R.A.	5	55	54	Dec. N.	23	37½
29th	„	5	57	57	„	23	38

Neptune may be observed in the evenings, coming to the meridian at a quarter to 2 in the morning on the 1st of September; it is situated in Pisces, midway between Pegasus and Cetus.

1st	R.A.	0	30	39	Dec. N.	1	38½
29th	„	0	27	57	„	1	20½

Pallas, one of the first discovered of the minor planets, is now well fixed for telescopic observation, being close to the equator.

Sept.	7th	R.A.	22	15	Dec. N.	3	6	
	17th	„	22	8	„	0	57	Size = 9th Magnitude.
	27th	„	22	3	„ S.	1	10	

THE MINOR PLANETS.

The following are the Minor Planets which will be on, or within one hour of Right Ascension, on either side of the Meridian, between nine and twelve o'clock during the evenings of September. Their places are to be found in the Supplement to the *Nautical Almanac* for 1867.

	Magnitude.		Magnitude.
Ceres	8·2	Atalanta	11·9
Pallas	8·9	Harmonia	9·1
Astrœa	11·3	Isis	9·0
Metis	10·4	Ariadne	9·4
Irene	10·4	Calypso	12·1
Psyche	10·0	Mnemosyne	11·1
Thalia	11·4	Olympia	11·1
Euphrosyne	12·8	Hesperia...	12·1

ASTRONOMICAL OCCURRENCES FOR SEPT. 1864.

DATE.		Principal Occurrences.		Jupiter's Satellites.		Meridian Passage.
		h. m.			h. m. s.	h. m.
Thur	1		Sidereal Time at Mean Noon, 10 43 36·3	2nd Oc. D. 1st Oc. D.	6 59 7 59	β Aquilæ — 9 3·5
Fri	2	2 47	Conjunction of Moon and Venus, 5° 24′ N.	1st Tr. E. „ Sh. E.	7 27 8 39	8 59·6
Sat	3	3 25	Conjunction of Moon and Mercury, 0° 24′ S.	3rd Sh. E.	7 29	8 55·7
Sun	4	1 7	Conjunction of Moon and Saturn, 4° 36′ N.			8 51·7
Mon	5		Declination of β Aquilæ, + 6° 4′ 17″			8 47·8
Tues	6	19 11	Conjunction of Moon and Jupiter, 0° 15′ S.			8 43·9
Wed	7					Moon — 4 30·9
Thur	8	17 50	☽ Moon's First Quarter			5 22·8
Fri	9			1st Tr. I. „ Sh. I.	7 12 8 21	6 17·0
Sat	10			2nd Sh. I. „ Tr. E. 3rd Tr. E. 1st Ec. R.	6 41 6 43 6 57 7 44 58	7 12·9
Sun	11					8 9·8
Mon	12					9 6·8
Tues	13	10 32 11 41 16 25	Occultation of C¹ Capricorni (6) Reappearance of ditto Conjunction of Venus and Mercury, 5° 36′ S.			10 3·4
Wed	14					10 59·5
Thur	15	9 9	○ Full Moon			11 55·1

DATE.		Principal Occurrences.		Jupiter's Satellites.		Meridian Passage.
		h. m.			h. m. s.	h. m. β Aquilæ
Fri	16		Sidereal Time at Mean Noon, 11 42 44·6			—
		15 30	Near approach of Moon to 60 Piscium (6)			8 4·6
		15 41	Occultation of 62 Piscium (6)			
		16 44	Reappearance of ditto			
Sat	17			1st Oc. D.	6 24	8 0·7
				2nd Tr. I.	7 1	
Sun	18			1st Sh. E.	6 58	7 56·7
Mon	19			2nd Ec. R.	6 23 28	7 52·8
Tues	20	21 13	Conjunction of Moon and Mars, 1° 41′ N.			7 48·9
Wed	21					7 44·9
Thur	22	5 54	Conjunction of Moon and Uranus, 4° 7′ N.			7 41·0
		6 54	☾ Moon's Last Quarter			
Fri	23	6 36	Conjunction of Venus and Saturn, 1° 36′ S.			7 37·0
		12 17	Conjunction of Mars and ι Tauri, 7m·6 E.			
		14 22	Near approach of Moon to λ Geminorum (3½)			
		14 51	Inferior Conjunction of Mercury			
Sat	24					7 33·1
Sun	25	14 19	Occultation of 60 Cancri (6)	1st Sh. I.	6 41	7 29·2
		14 35	Reappearance of ditto			
Mon	26			1st Ec. R.	6 2 55	7 25·2
Tues	27					7 21·3
Wed	28			3rd Oc. R.	5 42	7 17·4
				„ Ec. D.	7 21 25	
Thur	29	13 3	Conjunction of Moon and Mercury, 3° 0′ N.			7 13·5
Fri	30	10 43	● New Moon			7 9·5

TABLE OF NEBULÆ.

Right Ascension, Nineteen Hours.

<table>
<tr><th>NAME OF NEBULA.</th><th>Right Ascension.</th><th>Declination.</th></tr>
<tr><td>56 M. Lyræ ....</td><td>19 11 20</td><td>+29 56½</td></tr>
<tr><td colspan="3">A fine object, of some size, but without much tendency to condensation.</td></tr>
<tr><td>38 Hersch. vi. Aquilæ ...</td><td>19 25 5</td><td>+ 8 57</td></tr>
<tr><td colspan="3">A stellar Nebula, but small, hazy, and dim.</td></tr>
<tr><td>57 Hersch. v. Sagittarii ...</td><td>19 36 20</td><td>−14 27</td></tr>
<tr><td colspan="3">A planetary Nebula, small and pale blue, but bright and well-defined.</td></tr>
<tr><td>73 Hersch. iv. Cygni .....</td><td>19 41 15</td><td>+50 11</td></tr>
<tr><td colspan="3">A wonderful object! forming a link between the planetary and stellar Nebulæ.</td></tr>
<tr><td>71 M. Sagittæ...............</td><td>19 47 45</td><td>+18 26</td></tr>
<tr><td colspan="3">A fine oblong nebula, in a pretty field of stars.</td></tr>
<tr><td>27 M. Vulpeculæ............</td><td>19 53 45</td><td>+22 21</td></tr>
<tr><td colspan="3">A very large bright object, but without much tendency to condensation.</td></tr>
<tr><td>75 M. Sagittarii ....</td><td>19 58 5</td><td>−22 18</td></tr>
<tr><td colspan="3">Very small, but tolerably bright, condensing rapidly towards the centre.</td></tr>
</table>

Undoubtedly, the most striking object in the Nineteenth Hour of Right Ascension is the 4th one in our Table for this month, 73 Hersch. iv. Cygni. With the instrument and power employed, it resembles a tolerably bright star out of focus, exhibiting a curious contrast to the *real* stars in the field. With a high power it shows more of its nebulous character; but even under the greatest amplification, there is the suspicion of a stellar nucleus. 38 Hersch. vi. Aquilæ, is relatively scarcely perceptible when compared with this wonderful nebula. By attentively regarding 71 M. Sagittæ, an impression will at first be received that it is resolvable, but more careful observation will show that the glittering which conveys this impression, proceeds from some very minute stars disconnected with, but projected *upon* the nebula, which forms a background to them. 57 Hersch. v. Sagittarii is a fine though small specimen of a planetary nebula. 27 M. Vulpeculæ is the so-called "dumb-bell nebula," but its appearance scarcely justifies the appellation. The pictures of this in some popular works on astronomy are simply nonsense. It is large and bright, but without much tendency to condensation. The southern extremity is rather the brighter of the two, but there is very little differentiation of nuclei. The constriction which gives the effect of duplicity to this object is by no means free from nebulosity. This constriction is rather more apparent on the following side of the nebula than on the preceding one. 75 M. Sagittarii is a pretty little object; it condenses rapidly towards the centre into an almost stellar nucleus.

THE NEW COMETS.

Comet I. 1864.—The following elements are by Ischerepoff:—

$$\begin{aligned} T &= \text{Aug. } 15{\cdot}22837. \quad \text{B.M.T} \\ \Omega &= 95^\circ\ 30' \\ \iota &= 178\ \ \ 7 \\ \omega &= 150\ \ 57 \\ \text{Log. } q &= 9{\cdot}959410 \end{aligned}$$

Ephemeris from the above for Berlin mean noon:—

1864.		R.A. H. M. S.		Decl. ° ′		Log. dist. from Earth.
Aug. 25.	...	14 10 13	... S.	12 32·5	...	9·8576
26.	...	14 11 27	...	12 44·6		
27.	...	14 12 33	...	12 55·3	...	9·9030
28.	...	14 13 32	...	13 4·9		
29.	...	14 14 25	...	13 13·5	...	9·9437
30.	...	14 15 12	..	13 21·3		
31.	...	14 15 55	...	13 28·5		
Sept. 1.	...	14 16 34	...	13 35·0	...	9·9976

Comet II., 1864.—M. Donati communicates to the *Bulletin International* the following elements of his newly-discovered Comet:

$$\begin{aligned} T &= \text{Oct. } 11{\cdot}3343. \quad \text{G.M.T.} \\ \pi &= 261^\circ\ 38'\ 23'' \\ \Omega &= 31\ \ 20\ \ 51 \\ \iota &= 110\ \ 10\ \ \ 7 \\ \text{Log. } q &= 9{\cdot}98318 \end{aligned}$$

M. Donati has observed and measured several bands in the Comet's spectrum.

The August Meteors.—Mr. G. F. Chambers writes from Eastbourne:—"While the August meteors have not been numerous here, I saw on the 10th one entitled to special note. I made the following memorandum at the time:—'At 9h. 5m. p.m., a magnificent meteor, certainly more brilliant by far than Jupiter, passed through Lyra from E. to W. Its track was about 5° or a little more long, and it lasted about 3 seconds. Had it not been twilight the effect would have been very brilliant: α Ursæ Majoris, of Mag. 1, bore no comparison with it.'"—The following is from a letter from Mr. W. E. Hickson, of Wrotham:—"Did you see at Clapton, on the 6th, the brilliant meteor that appeared here at 10h. 20m. p.m., as if dropping almost perpendicularly from the Milky Way? It was of a dazzling light blue colour."

The British Association will hold its annual meeting this year at Bath, under the presidency of Sir C. Lyell, F.R.S., commencing September 14. Should anything of interest to astronomers occur, our good correspondent Mr. Birt has promised to take note of it for us.

TO CORRESPONDENTS.

N.B.—Articles received after the 20th of the month cannot be inserted unless containing notices of fresh discoveries, or otherwise of immediate interest.

We are still compelled to postpone several letters—among others, those of "Nauticus" and the "Rev. N. S. Godfrey," which are, however, in type. "G. J. W.," "J. R.," "E. H.," and some others in our next. "Jupiter" is requested to read the last two lines of the answer to "X." in our last number.

Rev. R. H.—Your suggestion as to the Double Star Diagrams is under consideration.

Received.—*Introduction to Geology and Magnetism*, E. Hopkins. *Victoria toto Cælo*, J. Reddie.

The change in our publishing office has caused some irregularities to take place in the transmission of the *Register*, which we trust will be avoided for the future. We hope, however, that our subscribers will give us notice if they do not receive their copies in due course.

ASTRONOMICAL REGISTER.—*Subscriptions received for the year* 1864—the Editor's list.

To June.
Bird, A.
Hickson, W. E.
Holland, Rev. C.
Key, Rev. H. C.
Ward, Major M. F.

To September.
Vallance, P.

To December.
Jackson, Mrs. H.
Jones, W. E.

August 24, 1864.

CONTENTS.

The Astronomical Register.

No. 22. OCTOBER. 1864.

ASTRONOMY AT THE MEETING OF THE BRITISH ASSOCIATION.

Although the neighbourhood of Bath is not celebrated for important manufactures or extraordinary works, and might therefore have been expected to contrast unfavourably with Newcastle-on-Tyne in providing objects of interest for a scientific gathering, yet the meeting of the British Association last month will, on the whole, bear a favourable comparison with that of 1863. In resigning the Presidential Chair to Sir Charles Lyell, Sir William Armstrong pleasantly alluded to the fairer aspect of Bath, as contrasted with the darker features of his own more northern town. Sir Charles Lyell's address was of a very interesting character, chiefly bearing upon geological and chemical subjects, the Bath waters, and the earth's crust: it contained no reference to astronomy.

Mr. Glaisher's report on *Luminous Meteors* was exceedingly well received: the most important point was the determination that these bodies were more numerous between the altitudes of 40 and 80 miles above the level of the sea. Another interesting feature was that about 20 radiant points had been determined, as giving rise to the great majority of shooting stars observed throughout the year.

Professor Hennessey's paper on the *Connection between the Ellipticity of Mars and the general appearance of its Surface,*

was highly important. The author spoke of Bessel and Johnston's observations, tending to the determination of a smaller ellipticity than was generally acknowledged: if the ellipticity were as great as usually given, there ought to be a protuberance of land in the equatorial regions. This the author did not think existed.

The paper by the Rev. T. W. Webb, *On a suspected Change in the Lunar Spot, Werner*, was also very important. The author considered that either Beer and Mädler's observations of the brightness of this point were erroneous, or that he himself was wrong, or that the spot had faded.

Mr. Birt's paper followed — *On the importance of adopting methods for the Detection of Change on the Moon's Surface.* The author's object being to form a perfect catalogue of lunar objects, so as ultimately to set at rest the question whether the surface of the moon is in a state of quiescence or slight volcanic activity.

Dr. Lee proposed, that in consequence of the importance of Professor Hennessey's paper, a committee should be formed for the purpose of observing Mars at the next opposition. It is also probable that a committee will be appointed for furthering the work in which Mr. Birt is engaged — the formation of a catalogue of lunar objects.

THE HARTWELL OBSERVATORY.

Ædes Hartwellianæ; or, Notices of the Manor and Mansion of Hartwell. By Admiral W. H. Smyth. 4to. London: privately printed.

Those of our readers who are amateur astronomers will not think a portion of the space of the *Register* wasted if we occupy it with a slight description of the Hartwell Observatory, and also of the residence of Dr. Lee, of which the above work by Admiral Smyth gives a most interesting and detailed account. Those who have the pleasure of knowing Dr. Lee need not be told how great a patron and promoter he has been of our favourite science, and all who have been at Hartwell can testify to his kindness and attention, rendering a visit there not only pleasant, but instructive—making it an event to be remembered with gratification.

Hartwell House is situated near to Aylesbury, in Buckinghamshire, and within a couple of hours' railway journey from town. The park and grounds are very fine, many of the trees, which are in great abundance, being of large size. It is not within our purpose to trace the different possessors of Hartwell from the time it was given by William the Conqueror to the Peverells, through the various generations of Hertwelles and Lutons to its present owner. We may merely state that the family of the Lees is an offset of the Lees or Leighs of High Lee and Lyme in Cheshire, the name being spelt in no less than five different ways —Lea, Lee, Legh, Leigh, and Ley. The baronetcy expired with Sir George Lee, who was rector of Beachampton, and lived alternately at that place and Hartwell. He died in 1827, bequeathing the estate and mansion to the next heir, the present Dr. John Lee.

Hartwell House was erected in 1570; it is nearly 200 feet in length by 70 or 80 feet wide, with a height of 45 feet. The apartments are very numerous, and conveniently arranged. In the year 1807 it was let at a rent of £500 per annum, by Sir George Lee, to the French Royal family, who took refuge in England from the troubles of their own country. Of this circumstance the visitor is reminded by numerous indications in and about the house. The French took possession in 1808, and there were sometimes as many as 200 persons quartered on the Hartwell premises at one time. The rooms had to be divided in the most ingenious way, in many cases to the great disorder of the mansion. Windows were cut through the walls, fixtures disarranged, and other destructions committed. Still, upon the whole, during a residence which occupied about seven years, all things passed off tolerably well. The King occupied the drawing-room. He was seldom seen beyond the limits of the house. The Queen had the large room over the library, and in this she died, and lay in state for some days. It was subsequently occupied by the ex-King of Sweden.

Several of the rooms on the upper floor, and also the chapel, are now appropriated by Dr. Lee to a museum, which is well arranged, and kept in good order. Here the student will find collected together specimens of the animal, vegetable, and mineral kingdom, with antiquarian curiosities, and a variety of works of art and industry. The noble collection of coins can only be referred to as one of the choicest treasures in the house; cameos,

intaglios, and engraved gems are also to be seen in abundance. Dr. Lee's library is very extensive, being the union of several collections. It is especially rich in mathematical and philosophical works; and we may add that one room of the house is set apart as a muniment-room, and contains an infinite variety of old deeds and papers, principally relating to Hartwell, some of which date back as far as the reign of King John.

Dr. Lee made the first step towards setting up an observatory at Hartwell in the year 1828, when he purchased, at the instigation of Admiral, then Captain, Smyth, a number of valuable astronomical instruments, belonging to the late Rev. Lewis Evans. Among these was the celebrated "Lee Circle," which he presented to the Astronomical Society, upon the condition that it should be lent to Captain Smyth, who made good use of it at Bedford, in conjunction with other means, in observations for his "Celestial Cycle." The remainder of the instruments Dr. Lee placed in the south portico of Hartwell House, which he converted into an observatory, commencing operations in April, 1830.

This was the first observatory at Hartwell, the principal instruments being a portable transit, of 24 inches in length, by Carey, a reflecting telescope of $5\frac{1}{2}$ inches aperture, and an excellent refractor, of 5 feet focal length and $3\frac{3}{4}$ inches aperture, by Tulley, equatorially mounted on a tripod. The clock was by Mr. Barton, of Ramsbury, in Wiltshire. There were also several portable instruments, circles, sextants, quadrants, &c.; and among others a vellum telescope, of 10 feet focal length and 2 inches diameter, by Campani, of Rome—a great curiosity in its way—which Dr. Lee exhibited at Mr. De la Rue's Soirée. The Doctor was, however, beaten in this instance by Mr. Williams, the Assistant-Secretary of the Royal Astronomical Society, who showed one no less than 14 feet long.

It was but a short time after this observatory was in working order that Dr. Lee, having thoroughly imbibed the love of astronomy and the use of astronomical instruments, which the pursuit of the science almost invariably engenders, determined to increase his means of observation, and commence the erection of the very complete building which is now known as the Hartwell Observatory. With the valuable aid of Captain Smyth, the building was commenced in 1831, and in a short time the transit-room

was completed and fitted for use. This room was built out from the south-east corner of the library at Hartwell House, one of the windows being converted into a doorway, so that the library and observatory are conjoined. This is "no small luxury," observes Admiral Smyth, in the *Speculum Hartwellianum*, "for a private establishment, where there is no necessity for constant application or continuous work, like that of turning a cutler's wheel. It often happens that there are intervals between the observations on the agenda for the evening; and frequently, as well as suddenly, the weather varies for a time, with a promise of clearing off again. Now in such cases here would be a desirable and pleasing retreat from the instruments into the 'House of Treasures,' as Ezra happily termed the depository of books and documents." The solidity of the foundations for the instruments, and the whole transit-room itself, may be judged of by the fact, that although the room measured but 18 feet by 12, 16 feet in height outside, and 10 feet 5 inches inside, with an ante-room of $8\frac{1}{2}$ feet, nearly 20,000 bricks were used.

The transit instrument is 5 feet in focal length, with an aperture of $3\frac{3}{4}$ inches; it has two reading circles at the eye end. The Y's are fitted with Brazilian pebbles, and it has the usual appliances of a first-class instrument. It was made specially for Hartwell Observatory by Mr. Thomas Jones, of Charing Cross, at a cost of 105*l.*

The clock was made by Mr. Vulliamy, of Pall Mall. It is fitted with mercurial pendulum and Graham's dead-beat; and the maker had a *carte blanche* to spare neither pains nor expense in producing a first-class instrument. It was completed at the same cost as the transit, viz. one hundred guineas.

The adjustments of the transit instrument are facilitated by means of north and south meridian marks, mounted on pretty little marble models of ancient temples, at a distance of 100 feet from the observatory, from which they are viewed by the transit instrument through lenses, of 100 feet focus, fixed in the walls, north and south, just beneath the meridian window slits. The marks are thus caused to appear at an infinite distance, and the wires can be accurately adjusted by their means.

(*To be continued.*)

MR. DE LA RUE'S SOIRÉE.

ARTICLES EXHIBITED AT THE SOIRÉE

Of Warren De La Rue, Esq. F.R.S., President of the Royal Astronomical Society, at Willis's Rooms, June 11th, 1864.

[Continued from p. 221.]

S. M. Drach, Esq. F.R.A.S.—Statue of Galileo, from that in the Tribune at Florence.

Messrs. Lloyd, Brothers.—Pictures:

The Falls of Tivoli, by the late F. Lee Bridell.

Another picture, by the same.

The Nativity, by Von Schendall.

Another picture, by Henry Moore.

Dr. Lee, F.R.S. and Admiral Smyth, F.R.S —A Windlass for raising a Revolving Roof to adjust the Balls.

Two Lithographs of Celtic Discoveries made recently in Northumberland, at the expense of the Duke of Northumberland.

Vellum Perspective, 10 ft. focal length, 2 in. aperture, made by the celebrated Giuseppe Campani at Rome, A.D. 1650, he being the Fraunhofer of the day.

Two Runic Staffs.

Runic Almanac.

Board for indicating the Readings of Barometer. Three Scales, constructed by Thos. Sopwith, Esq.

Specimens of the Hartwell Sand.

Various Specimens of Glass made from the Hartwell Sand.

E. W. Brayley, Esq. F.R.S.—Selection of Meteorites, and Diagrams of Meteorites.

Henry F. Holt, Esq.—A Telescope, date 1608.

Note.—It magnifies about twice, and has a remarkably small field of view.

C. V. Walker, Esq. F.R.S.—A variety of Apparatus connected with the transmission of true Time from a Normal Observatory to any number of distant stations.

Hamilton Field, Esq. F.R.A.S.—A Volume of Hooke's Tracts, showing a Plan for an Equatoreal driven by Clock-work, governed by a Conical Pendulum. A very complete Collection of Hogarth's Original Engravings.

W. Tite, Esq. M.P. F.R.S.—Two Pocket Dials. Pocket Perpetual Almanac.

Captain George, R.N. F.R.A.S.—Pocket Sextant, of new construction.

J. Hart, Esq.—A Demonstrating Opthalmoscope.

J. T. Barber, Esq. F.R.A.S.—Position Micrometer.

H. Perigal, Jun. Esq. F.R.A.S.—Illustrations of Compound Circular Motion.

Lieut.-Col. W. F. De La Rue.—A piece of the Flagstaff of Fort Sumter, a Fragment of a Parrott-shell fired against that Fort, and a

Brick dislodged from the Fort. (Authenticated by General Beauregard's autograph.)

Professor ROSCOE, F.R.S.—The New Magnesium Lamp, which has been employed for the production of Photographic Portraiture by night.

S. HEIGHLY, Esq.—Photographic Slides, illustrative of Science, for the Magic Lantern.

OCTAVIUS MORGAN, Esq. F.S.A.—Quadrants, and other small early Astronomical Instruments.

C. HEISCH, Esq. F.C.S.—A Collection of Photographs, Microscopes, &c.

A. F. CLAUDET, Esq. F.R.S.—Specimens of the new process of Photo-sculpture.

J. F. ABEL, Esq. F.R.S. (*Royal Arsenal, Woolwich*).—Photographs illustrative of Military Equipment, and of Artillery Practice.

Portrait of Dr. Hoffman. Portrait of Garibaldi.

Dr. GILES.—Original Sketches by Thackeray, made in 1832, before this author was known to fame.

JOHN YOUNG, Esq.—A Collection of Autographs and Portraits of Men of Science.

Professor TENNANT.—Rare Minerals and Gems.

Dr. WRIGHT.—Rare China.

S. W. SILVER, Esq.—A Collection of Chinese Coins.

HENRY LOWCOCK, Esq.—A Collection of Japanese Coins.

W. D. HAGGARD, Esq. F.R.A.S.—A Double Protractor.

RICHARD ABBATT, Esq. F.R.A.S.—Educational Diagrams.

BENJAMIN SCOTT, Esq. F.R.A.S.—Educational Diagrams.

S. S. GLENNIE, Esq. F.R.A.S.—Papyri, &c., collected by the Exhibitor in the East.

C. FRODSHAM, Esq. F.R.A.S.—Astronomical Clock, connected with Chronograph, the Recording Wheels of Ebonite and Aluminium—Steel Pendulum Jars, preferable to those of Iron. Sidereal Chronometer. Thirty-five Days' Marine Chronometer. Stop Split-centre-seconds Watch. Watches of various kinds. Very large Two Days' Portable Chronometer. Chronometer with tourbillon Escapement.

Dr. STEINHEIL, *Munich*.—A Telescope of new construction on Gauss's principle, and embodying the Seven Desiderata set forth by Gauss. (*For sale.* Price 36*l.*)

Messrs. MERTZ, Munich.—A 10-inch Astronomical Object-Glass of unusually short focal length, namely, 10 feet. (*For sale.* Price 350*l.*)

E. WHEELER, Esq. F.R.A.S.—Folio Cases of Microscopic Objects. Large Gyroscope. Transparent Painting of the Eruption of Vesuvius. Aluminium Telescope. Pocket Mountain Aneroid Barometer. Acoustic Syrène.

THOMAS ROSS, Esq.—A Series of Microscopes. Binocular Camera, with 2 Actinic Triplets. Astronomical Telescope on Altazimuth Stand. Terrestrial Telescope.

Messrs. HORNE & THORNTHWAITE.—Garden Telescope, equatoreally mounted. An Equatoreal Stand for 3½-foot Telescope. Apparatus to illustrate Diffraction and Interference. New Form of Polariscope. A Set of Test Objects.

Messrs. Smith, Beck, & Beck.—Stand for Microscopes.
Series of Microscopes.
Six 18-inch Photographs of the Moon, enlarged from the negative taken by the President. Stereoscopic Views of the Moon. Scraps relating to the Solar Eclipse of 1860, Barometer, &c. A 12-inch Object-Glass by Grubb, of Dublin.

Messrs. Powell & Lealand.—A Series of Microscopes and a $\frac{1}{25}$th and other Object-glasses of large aperture.

W. Ladd, Esq.—A variety of Vacuum Tubes and Experiments with the Inductive Coil. The Sonorous Vibrations of Elastic Plates. A new Form of Syrène.

The President's Photographs of the Eclipse, and Apparatus for showing the Corona, &c. by the Electric Light.

Messrs. Cooke & Sons, *York*.—Equatoreal and other Astronomical Instruments. Model of an Observatory.

Messrs. Elliott, Brothers.—Heliostat. Heliochronometer. Large Case of Drawing Instruments. Musical Vibration Apparatus. Set of Astronomical Eye-pieces.

J. P. Casella, Esq. F.R.A.S.—Robinson's Anemometer (Kew model). A Set of Meteorological Observatory Instruments. A Set of Tourists' Meteorological Instruments. A new Aneroid Barometer.

P. Adie, Esq.—Self-recording Anemometer on the Kew pattern, reduced scale. Patent Telemeter, or Distance Measurer. Patent Theodolite Level. Patent Level. Patent Surveying Compass. Standard Barometer for Observatory.

Messrs. Troughton & Simms.—Zenith Sector. Horizontal Circle of a 3-feet Theodolite. A 10-feet Standard.

J. H. Dallmeyer, Esq. F.R.A.S.—A Photoheliograph made under the direction of the President for the Wilna Observatory, Russia.

Silver's "India-rubber Works and Telegraph Cable Company." Electrical Apparatus. Articles in Ebonite. Gum Balata, &c.

Messrs. Hopkin & Williams.—The new metal, Thallium, and other rare Chemical Substances.

J. How, Esq.—Microscopes. Model of Electro-Magneto-Motive Machine, and Circular Saw in action.

J. Browning, Esq.—Spectroscopes. Large Prism of very dense Flint-glass. Aneroid Barometer. Mountain and Pocket Aneroid Barometers.

Cambridge University.—Professor Adams' report to the Syndicate mentions that the office of first assistant at the Observatory, vacant by the resignation of Mr. Bowden, will be filled up by Mr. Graham, of the late Mr. Cooper's Observatory at Markree. The instruments are in good repair generally. A new eye-piece has been provided for the Northumberland Equatorial, by Cooke & Sons, on Steinheil's plan, and a diagonal reflector for observing the sun has been ordered from Mr. Simms. The equatorial observations comprise some of comet iv. 1863; occultations; phenomena of Jupiter's satellites, &c. Numerous observations of meteors were made on the night of August 10, which have been of considerable use to Mr. A. S. Herschel in his investigations.

CORRESPONDENCE.

N.B.—We do not hold ourselves answerable for any opinions expressed by our correspondents.

LUNAR PHYSICS.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—Allow me to mention that in addition to the original drawing of the Nebula of Orion, the Earl of Rosse exhibited at the Soirée of the President of the Royal Astronomical Society a series of "Photographs of portions of the Moon, from drawings executed at the telescope by lamplight." This series appears to be very valuable, and although *for effect* it can bear no comparison with Mr. Nasmyth's series of colossal drawings, yet when these are placed side by side with it, and examined with the original—viz. the "Lunar Surface"—*at the telescope*, Lord Rosse's drawings are at once seen to possess a value which will greatly tend to render them indispensable companions of a lunar observatory. At all events, I expect to find them of very considerable assistance in the work I am now engaged upon, viz. the formation of a catalogue of lunar objects. The drawings include the following objects:—(1.) Aristarchus and Herodotus, and the space between them under different illuminations, and (2.) in full sunlight; (3.) Gassendi, *all* details within the walls and the western wall, with portions of the eastern wall; (4.) Archimedes; (5.) Fracaster; (6.) Guttemberg; (7.) Parry and Bonpland; (8.) Parry at sunset; (9.) Guerike, unfinished; (10.) Wargentin; (11.) Part of the Apennines, including Mount Huygens; (12.) Petavius; (13.) Hekateius; (14.) Plato, in full sunlight, and (15.) at sunrise, showing the minute craters on its floor; (16.) the northern portion of the Montes Hercynii, and (17.) a portion of the Mountains Leibnitz.

May I take the liberty of soliciting the attention of those of your readers who are interested in lunar physics, to the region about "Marius," as one demanding close scrutiny and the most careful inspection under competent telescopic power. The points of greatest interest are the existence of two craters, figured and described by Schröter—one, IICλ^5, on the SW. border of Marius (see antè, p. 184), and one on a curious plain north of Marius. This plain appears to have quite arrested the attention of Schröter; he has figured it with numerous hillocks on its surface, and the crater on it, IICλ^{16} is shown very conspicuously. Both these craters are omitted by Beer and Mädler. I have, however, seen each of them IICλ^5 readily under the circumstances mentioned in my last letter (see antè, p. 184); the other IICλ^{16} *occasionally*, but it was seen *distinctly* on the night of August 14, 1864, with the Hartwell equatorial, powers, 118, 185, and 240. The plain itself, IICλ^{15}, is, according to Schröter, very curious. I have not yet detected anything very remarkable upon it, but I have the

following record relative to it: "The plain north of Marius Schröter shows as if it were *raised* and of a *brighter* tint. I see it (Aug. 14, 1864,) as it is sketched (date June 16, 1864), but *depressed* and of a slightly *darker* tint." Should opportunities be afforded, I hope to be able to examine it very carefully during the approaching winter.

The region east of Marius and north of Reiner is particularly described by Schröter, who depicts on T. lx., fig. 3, and mentions in his text, 16 distinct elevations, viz. k, l, m, n, p, q, r, s, t, v, w, x, y, z, α and γ, as well as showing in his drawing many others not designated. Beer and Mädler also refer to this region and speak of as many as 100 hills existing here, of which the highest is ϵ, IICλ^{20}, which is situated on the west wall of the half crater IICλ^{11}, according to Beer and Mädler it is 163 toises, or 1,042 English feet, high. It is q of Schröter. It is among these hills that the crater IICλ^{3}, e of Beer and Mädler, is situated (see anté, p. 183), and the balance of evidence is in favour of this crater having been opened between 1792 and 1834. There are, according to Schröter, two interesting formations in this locality, both having greatly the character of half-craters. The nearest to Marius on the east, IICλ^{11} is figured by Schröter, T. lx. fig. 1, B. This I have distinctly seen, but record it "not at all so deep as shown by Schröter." It is proper to remark this is only *an estimation*. Its highest peak, as mentioned above, is 1,042 feet, according to Beer and Mädler. The wall of Marius rises, according to the same authorities, 4,553 feet above the interior floor, but according to Schröter 6,850 feet. I have been able, by the aid of the Hartwell equatorial, on the night of August 14, 1864, nearly to trace the completion of the ring of this apparently half-crater in the east by a low ridge of hills, imperfectly shown by Schröter; the comparatively high west ridge, with the low east ridge, enclosing a somewhat smooth interior, IICλ^{13}, which, however, is not so *smooth* as the floor of Marius. The difference between the two ridges is very marked, and the west, or most conspicuous, is terminated by two distinct formations; that on the south being a nearly filled crater, IICλ^{14}, and that on the north by the crater IICλ^{3}, e of Beer and Mädler. There are some indistinct traces of the enclosure IICλ^{13} on Beer and Mädler's map. Schröter speaks of a second half-crater more to the eastward, near to his n and p, which I have not yet observed.

I shall be happy at any time to receive information relative to the interesting region around Marius; and, indeed, to any portion of the moon's surface. The Rev. T. W. Webb has alluded to the Marius region in two most interesting letters in the *Reader*: one will be found in the impression of July 9, 1864, p. 54, the other on p. 111 of July 23, 1864. The subject is well worth the attention of lunar physicists, and is I believe increasing in interest.

I am, Sir, your obedient servant,

W. R. BIRT.

Victoria Observatory,
Victoria Park, London, N.E.:
September 3, 1864.

THE SUPERIOR CONJUNCTION OF VENUS.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—The remarks of the Rev. W. R. Dawes on my "Notice of Venus" are accompanied with so much information of general interest and practical value, that I am sure you will permit me to thank him through the medium of the *Register*. Absence from home prevented me from following the planet up to the conjunction, which I was led to suppose difficult from a statement in *Lardner's Handbook of Astronomy*, that "Venus was observed on the 19th February, 1858, with the transit-circle at Greenwich, when very near superior conjunction, the interval of time between the meridian passages of the planet and the sun being less than six minutes."

Mr. N. Green suggested to me the use of a diaphragm of small aperture for observing the satellites of Saturn, but it certainly would not have occurred to me to use it in the way Mr. Dawes so well describes. And if he and others with his ability and experience would continue to notice the observations of your less-informed and more inexperienced correspondents, one very important object of the *Register* would be attained—the diffusion of useful and practical information, of a kind so often desired and sought for from books in vain.

I am, Sir, yours faithfully,

Ealing: Sept. 18, 1864. W. L. BANKS.

THE SATELLITES OF SATURN.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—I am happy to see that the suggestion of S. B. K. in the August number of the *Register* is likely to be carried out. I believe it will be the means of drawing the attention of many observers to this highly interesting planetary system. Many observers are not aware of how much may be seen even with small telescopes. As proof of this, allow me to state what I have done in the way of seeing. I have been a pretty constant observer of Saturn since March 1862, with a telescope of 36 inches, focal length, and only 2 inches aperture. With this a power of 50 always shows Titan plainly, and nearly always Iapetus; a power of 65 gives uncertain glimpses of two more, and 80 has in very favourable weather shown four with careful gazing.

This same clearly shows the two principal belts on either side of his equator, the shadow of the ring on the planet, and of the planet on the ring; and during the last opposition, though I failed to see the division of the ring, the great difference of brilliancy between its inner and outer edge was most clearly visible, and I have strong hopes of seeing it even with this small aperture when its situation is more favourable.—Without further trespassing on your time or space,

I am, Sir, yours respectfully,

Red Lion Street, Chesham, Bucks: CHARLES GROVER.
September 16, 1864.

THE NEW COMET.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—The following positions of the new Comet may interest some of your readers.

		R. A.				Dec.	
		h.	m.	s.		°	′
Sept. 25	...	10	34	56	+	43	54
„ 30	...	10	39	54	...	47	18
Oct. 5	...	10	44	55	...	50	49
„ 10	...	10	51	32	+	54	7

Your obedient servant,

Sept. 27, 1864. GEORGE F. CHAMBERS.

EQUATOREAL v. EQUATORIAL.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—In reply to Q., equatorial, I think, can be the only correct way of spelling; according to the fashion of such words as æquinoctial, differential, inquisitorial, dictatorial, &c. &c. They all preserve the vowel of the genitive ending, which is *i*, not *e*. If *-lis* be the Latin ending of such words, the *a* may be a conjunctive vowel; or if we suppose them formed as Dr. Donaldson (Varronianus) regards such a word as regalis—reg-ya-lis, the *ya* being the second prenominal element, then equatorial would have been equator-ya-lis, which becomes in its English form equatorial. So I find it spelled in all the books I can refer to, except in Mr. Hind's Vocabulary, where he writes it with an *e* (though immediately *æquinoctial* follows with an *i*). This may be owing to a misprint, or it may be one of the many slips and inaccuracies to which we are all liable unless our attention is specially drawn to the subject. I daresay I have written equatoreal and meridional myself before now; but the latter coming directly from meridianus, can by no means have an *o*, which must be owing to careless pronunciation transferred to writing. Those of us who may have fallen into these trivial mistakes may comfort ourselves that writers like Sir John Herschel and Admiral Smyth are guilty of writing meridional. Such a word as sidereal, of course, coming directly from Sidereus, is properly spelled with an *e*.

Yours, &c.

G. J. W.

THE SUN'S DIAMETER, AND MOON'S ROTATION.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—As the subject of the solar diameter is of too much importance to be lightly dismissed, allow me to call your attention to some points of the question which your correspondents have overlooked.

First, it should be understood that the solar diameters of the *Nautical Almanac* are not *observed* diameters, but computed diameters; not diameters measured at any point of the earth's surface, but diameters calculated *for the earth's centre*; with the help in part only of Greenwich observations, and of certain rules laid down for refraction and parallax. In comparing, therefore, the measurements of different observers, we cannot proceed a step without knowing whether or not their solar diameters have been corrected by the same rules for refraction and parallax that would be followed by Mr. Airy.

Second, the value of those rules for refraction and parallax is hence a serious part of the inquiry; the more so since the æronautical ascents of Mr. Glaisher have demonstrated that we, as yet, know very little of the atmosphere as a refracting medium. And this leads me to remark, that the measurements given us by Mr. Howlett, in your last number, afford no rule for any two days of the year. At the low elevation of 5° or 10° the varying shape of the solar disc, as affected by atmospheric changes, is less an astronomical than a meteorological study. Whether the sun will sink as a perfect sphere, or assume an oval or disc-like form, depends on the clearness and dryness of the air, or the quantity of aqueous vapour through which the orb may be viewed. Two winters ago we had in this neighbourhood, from the effects of a distant snow-storm, the curious spectacle of an elongated *parhelion*, or mock sun, visible some minutes before sun-rise! At an altitute of 5° I have often seen the edge of the solar disc so flickering and serrated, that no two observers could possibly measure it alike.

Third,—it is essential to the object that every one who proposes, with Mr. Howlett, to measure the sun's *vertical* and *horizontal* diameters, should consider what he means by these terms. The vertical line of an observer, a perpendicular from his zenith, shifts, every second, from the earth's diurnal rotation; but as the direction of the sun's poles does not shift with it, an observer's vertical bisects at every instant a different part of the sun, and thus becomes worthless as a standard.

This effect of diurnal rotation is best studied by watching the apparent changing positions of familiar objects in the moon. The *Mare Crisium*, for example, does not appear at the same angle with a plumb-line, when the moon is on the horizon, as when the moon is on the meridian. Not that its situation has altered, but that its perspective has become different from our change of place.

From a similar cause, even if we confine ourselves to meridian observations, the noon vertical of an observer in one latitude does not agree with the noon vertical of an observer in a different latitude. The zenith of an astronomer at the Cape of Good Hope is so greatly different to that of an astronomer at Greenwich, that the two observers measure wholly different parts of the sun at the same hour of the day, although calling both vertical diameters. All evidence of the sun's magnitude built on data thus obtained is of course as fallacious as would be our knowledge of the dimensions of the Great Pyramid of Gizeh, if Egyptian travellers had been in the habit of measuring the sides and base, and confounding them with the height.

The astronomy of the future will owe much to the recent observa-

tions of Mr. Secchi, of Rome, who has shown that the maximum of the sun's force is on its equator. When this discovery has been thought over, it will be seen that our mathematicians must take a new base line for their computations. The plane of the solar equator must be substituted for the plane of the ecliptic as a horizontal, and the sun's axis must be taken as the only true vertical of the solar system.

Your obedient servant,
W. E. HICKSON.

Fairseat, Wrotham:
Sept. 5, 1864.

P.S.—By way of note to the above, let me add a few words on the merits of the discussion in your pages on what is called the moon's axis.

Our authorities have been accustomed to apply the term "axial rotation" to phenomena somewhat similar, but not exactly alike:—(1) To a body that turns within itself round a fixed centre, as a spinning-top, or the sun; and (2) to a body *turned* within itself but not about the same point of space, and so turned only in consequence of circular progression, as the moon; or as when, to use Mr. Dawes' illustration, a person walks round a table keeping his left shoulder to the middle.

In this latter sense it would be correct to say that St. Paul's turns upon its axis; for observe how a lunarian, viewing St. Paul's through a telescope, might reason on the same premises. "Clearly," he might say, "this singular dome-looking body rotates on its axis, for its peak or cross is directed to opposite points of the compass every twenty-four hours, and its inner face is always turned towards the earth's centre."

In the same sense every nail in the tire of a carriage-wheel rotates on its axis, when the wheel is put in motion; but this would not be popular English; and the question is, whether philosophers might not, with advantage even to those who understand their meaning, learn to express themselves with greater precision—in this case the more especially, as there are fair grounds for entertaining the hypothesis that the governing cause of the moon's motions may be a magnetic axis within the earth.

THE MOON CONTROVERSY.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—A great mathematician, Professor De Morgan, seems likely to be lugged against his will into the Moon Controversy. In the *Athenæum* of September 10 he notices Mr. Perigal's pamphlets on the subject, and also the lines by "Cyclops." In answer to the demand of the latter for a proof of rotation, the Professor intimates that a proof demands a *capacity for the reception of proof!* If the only proof of rotation is such as is incapable of being understood by a mind of the

usual capacity, I fear the theory is based upon a very unsubstantial foundation. The Professor says the subject may possibly revive again, being a tempting one: this is scarcely candid, for he could not well help knowing that it was then under active discussion, as will be seen from a letter in the *Register*, for this year, p. 142.

But I am glad to see that a writer of the calibre of the Rev. W. R. Dawes has entered into the controversy with such spirit; it shows that the subject is of more importance than the mathematical dons will admit: quiet and temperate discussion tends much more to convince those who are in error, than a mere ignoring of the controversy with an assumption of mathematical infallibility. In answer to the letter of Mr. Dawes in the September number of the *Register*, it is to be observed that the body on the circle (see diagram), by virtue of its continuous revolution in the orbit denoted by that circle, has turned round a quarter of a complete turn when it arrives at *c* from *a*. The body on the square travels in a straight path and does not turn; but when it arrives at *B* it stops, and turns or rotates on its axis a quarter of a turn. The moon does what the body on the circle does, but certainly not what that on the square does—the moon *does not* travel in a square orbit. This is only another instance of similar results being produced by different causes; it is simply evident that the body on the square, unless it stop in its path, cannot turn round to the extent of 90°: its motion changes at each angle.

Mr. Dawes' argument, in proof that a man must necessarily be rotating because he becomes giddy, will not bear criticism. Although a person would certainly become giddy if he ran round a small table, keeping one shoulder to the centre, he would not do so if he ran round London in a circle, with the same shoulder always towards St. Paul's. Giddiness in the former case is the result of his *revolving* in a small circle; let the circle be sufficiently large, he will not become giddy. This most fallacious argument is brought forward by Sir John Herschel, in his "Outlines;" but it can no more be said that because a man is giddy he has therefore been rotating, than that because he is tipsy he has therefore been drinking port wine! The fact being that his giddiness may have been caused by his revolving in a small circle, and his inebriety from an over-indulgence in sherry.

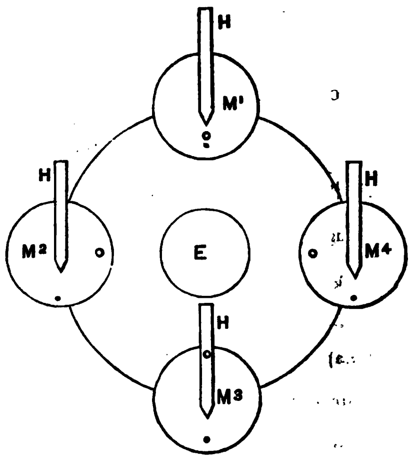
The question of the rotation of the moon on its axis seems to resolve itself thus: the orthodox, or those who maintain the rotation, assert that the terms revolution and rotation may be used to describe the same effect; the heterodox insist that these terms mean entirely different kinds of motion. The orthodox consider that an axis always maintains its position in space; the heterodox, that it always presents the same side foremost in the orbit or path in which it travels. It is not to any purpose encumbering your pages with illustrations and diagrams, which may be used with equal effect on either side of the question. We all know what the moon actually *does*; that she travels round the earth, presenting one side always to us, but turning round so as to present all portions of her surface to a spectator outside of her orbit; the disputed point is simply what this movement of turning round should be called, or really is.

I am, Sir, &c.

Cambridge: Sept. 19, 1864. AN ENQUIRER.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—Had it not been for the continuance of the controversy concerning the moon's rotation, I should have thought Mr. Slugg's letter in your June number would have decided the point in dispute. That it should be a point in dispute has all along been a matter of astonishment to me. I beg to enclose a diagram, which any one can reproduce upon cardboard, and by making a disc M rotate by means of a pin in a handle H to represent its own axis, the alternative is continuously shown, viz.:—



Either the moon must present the same face to us, and vary her position relatively to an imaginary handle; or, she does not vary that position, and consequently does not always present the same face.

For preserving the parallelism of the handle H, H, in M 1 its pointer points to the dot, which dot faces the earth E. In M 2, if the pointer point to the dot, or, in other words, if the moon do not rotate on her axis, the dot is no longer on the side next the earth; while in M 3, the handle and disc being relatively at rest, the dot is on the opposite side, and a completely new portion of the disc is presented to E. This is the consequence of the assumption that the moon does not rotate on her axis. But if she always present the same face, indicated on M 1, 2, 3, 4, by the letter o, it is clear by inspection that that letter must alter its position relatively to the index on the handle, or, in other words, must rotate on its axis.

May I be allowed to express my regret at the tone of the letters addressed to you? I think it is hardly worthy of men professedly engaged in so sublime a study as that of astronomy; and the natural effect is to deter many from giving expression to their thoughts, they being reluctant to encounter ridicule and sarcasm from those who are more confident although perhaps not more competent than themselves.

I am, Sir, yours faithfully,
N. S. GODFREY.

St. Bartholomew's Parsonage, Southsea:
July 13, 1864.

[*Some of our Correspondence is unavoidably postponed.*—ED.]

THE AUGUST METEORS of 1864.

M. Coulvier Gravier states that the hourly number of meteors from July 1st was as follows:

July 1	3·9	August 1	21·1
5	6·8	4	25·5
8	6·9	7	36·6
13	8·0	10	63·9
26	10·0	13	31·5
29	13·9		

This hourly number is below that of last year by 2·8.

Mr A. S. Herschel considers that the possibility of determining the difference of longitudes has been practically illustrated by the observation of two meteors simultaneously on the continent and in England:

Meteor 1, August 6.

	h. m.	Difference.
Local Time, Wrotham, (Seven Oaks)	10 20 P. M.	
" Paris	10 30	10 m.
" Münster (Westphalia)	10 52	22 m.

Meteor 2, August 9.

Local Time, Hawkhurst, (Kent) ...	12 52 A. M.	8 m.
" Paris	1 0	

The time of Münster is in advance of Paris 21 min. 11 sec., and of Greenwich, 30 min. 31 sec., and the time of Paris is in advance of Greenwich 9 min. 20 sec.; the difference between English and Paris times is found as nearly in the mean of both results as the difference between the times of the capitals, Paris and Münster, in the first.

The display of meteors was more brilliant on the 8th and 9th than on the 10th of August: this is accounted for by the occurrence of leap year.

Mr Bishop's Observatory.—We learn that Mr Bishop is about to publish a detailed description of his observatory, which has recently been removed to Twickenham. It is to be accompanied by tables of the planets, minor planets, comets, and variable stars, the new masses and distances depending on Hansen's solar parallax, and in short, everything which such a high authority as Mr Hind, under whose supervision it is being prepared, considers necessary for an astronomer's handy book.—*Reader*.

TABLE OF NEBULÆ.

Right Ascension, Twenty-one Hours.

NAME OF NEBULA	Right Ascension.	Declination.
15 M. Pegasi	21 23 25	+11 34
A splendid object ! condensing rapidly towards its brilliant nucleus.		
2 M. Aquarii	21 26 30	— 1 25½
A superb globular mass, the condensation less abrupt than in the preceding one.		
30 M. Capricorni	21 32 40	—23 45½
Rather bright and shewing a palpable nucleus, notwithstanding its small altitude.		

The Nebulæ in the twenty first hour of Right Ascension are but three, but they are—and notably our two first—of the greatest beauty and interest. 15 M. Pegasi is really splendid; it condenses, as we have said, rapidly towards its brilliant nucleus, and exhibits, perhaps best to an averted eye, faint outliers spreading all around it. It is *just* resolved in a 4·2 inch achromatic with a power of 74. 2 M. Aquarii is another brilliant and beautiful nebula, the light, while equally bright with that of 15 M. Pegasi, is diffused over nearly the whole of this splendid large globe, and consequently the condensation is not so striking as in the case of the former, although 2 M. Aquarii is on the whole the brighter of the two. The glitter of resolvability is obvious, but we cannot say that this superb sphere is actually resolved. Almost following and in contact with this nebula is an extremely minute star, which is evidently totally unconnected with the main cluster. 30 M. Capricorni is bright, and one might almost suspect signs of resolvability in it; the nucleus is very well defined. It is brighter on the south or top end, and when best seen presents something of the figure of a "spanish peg top." It is considerably smaller than either of the preceding objects.

THE PLANETS FOR OCTOBER.

Mercury is now visible in the mornings, rising shortly before five o'clock on the 1st, and about a quarter past 6 on the 31st. It passes from Leo to Virgo, and arrives at its greatest westerly elongation on the 9th.

1st	R.A.	11 42 43	Dec. N.	1 34	Diameter	8″·6
31st	,,	14 1 37	,, S.	11 17½	,,	4″·8

Venus leaves the constellation Virgo and passes into Scorpio during October, and although not quite so near to the Sun, is still

badly fixed for observation. It sets about a quarter past six in the evening at the beginning, and about half past five at the end of the month.

1st	R.A.	13 47 32	Dec. S.	10 34½	Diameter	10″·4
31st	„	16 15 1	„	22 7	„	11″·6

Illuminated portion of the disc of Venus=0·917.

Mars rises in the evenings shortly after eight o'clock at the beginning of the month, and is a brilliant object during the night: it continues in the constellation Taurus.

1st	R.A.	4 57 20	Dec. N.	21 52½	Diameter	12″·4
31st	„	5 9 12	„	23 18½	„	15″·2

Illuminated portion of the disc of Mars=0·913.

Jupiter and **Saturn** remain invisible.

Uranus continues in the constellation Gemini, rising about nine o'clock in the evening at the beginning of October.

3d	R.A.	5 38 0	Dec. N.	23 38
31st	„	5 56 42	„	23 38½

Neptune may be well seen during the month of October; it is about a degree north of the equator.

3d	R.A.	0 27 32	Dec. N.	1 18
31st	„	0 24 53	„	1 1

Ceres is in opposition on the 10th of the month, and may prove interesting to those who wish to observe one of the first discovered of the minor Planets.

7th	R.A.	1 34 0	Dec. S.	5 37	Size=8th magnitude.
27th	„	1 17 0	„	6 32	

THE MINOR PLANETS.

The following are the Minor Planets which will be on, or within one hour of Right Ascension on either side of, the Meridian, between nine and twelve o'clock during the evenings of October. Their places are to be found in the *Supplement* to the *Nautical Almanac* for 1867.

	Magnitude.		Magnitude.
Ceres	8·0	Isis	9·4
Pallas	9·0	Ariadne	9·9
Metis	8·5	Echo	11·8
Thalia	11·5	Maximiliana ...	11·9
Amphitrite ...	8·9	Hesperia	11·8
Atalanta	11·9	Clytie	—
Harmonia ...	8·8		

ASTRONOMICAL OCCURRENCES FOR OCTOBER, 1864.

DATE.		h. m.	Principal Occurrences.	Jupiter's Satellites.	Meridian Passage.
Sat	1	 12 55	Sidereal Time at Mean Noon, 12 41 52·8 Conjunction of Moon and Saturn, 4° 13′ N.	The Satellites are invisible this month, Jupiter being too near the Sun.	h. m. Alpha Aquarii. — 9 15·4
Sun	2	8 3	Conjunction of Moon and Venus, 1° 18′ N.		9 11·5
Mon	3				9 7·5
Tues	4	9 15	Conjunction, Moon and Jupiter, 0° 52′ S.		9 3·6
Wed	5		Declination of α Aquarii, —0° 58′ 18″		8 59·7
Thur	6				Moon. — 4 11·7
Frid	7				5 5·8
Sat	8	3 37 7 17 7 48 7 21 8 8	Moon's First Quarter Occultation of ρ^2 Sagittarii Reappearance do. (5½) Occultation of ρ^1 Sagittarii Reappearance do. (4)		6 0·6
Sun	9	2 10 8 35 9 28	Greatest Westerly elongation of Mercury, 18° 0′ Occultation of β Capricorni Reappearance of do. (3)		6 55·5
Mon	10				7 50·1
Tues	11	21 0	Conjunction of Venus and α^2 Libræ, 4m·4 E.		8 44·4
Wed	12				9 38·6
Thur	13	15 9	Conjunction of Saturn with the Sun.		10 33·1
Frid	14	6 59 7 48 18 15	Occultation of ϵ Piscium Reappearance of do. (4) Full Moon		11 28·3
Sat	15				12 24·3

DATE.			Principal Occurrences.	Jupiter's Satellites.		Meridian Passage.
		h. m.			h. m. s.	h. m. Alpha Aquarii.
Sun	16		Sidereal Time at Mean Noon, 13 41 1·1			8 16·4
Mon	17					8 12·5
Tues	18	17 56	Conjunction of Moon and Mars, 3° 10′ N.			8 8·5
Wed	19	14 12 18 52	Conjunction of Moon and Uranus, 4° 15′ N. Conjunction of Jupiter and Beta Scorpii, 8m·0 E			8 4·6
Thur	20					8 0·7
Fri.	21	23 27	Moon's Last Quarter			7 56·7
Sat	22	17 40 18 31	Occultation of A² Cancri Reappearance of do. (6)			7 52·8
Sun	23	14 5 15 5	Occultation of ω Leonis (6) Reappearance of ditto			7 48·9
Mon	24					7 45·9
Tues	25	7 16	Conjunction of Saturn and Mercury, 0° 44′ S.			7 41·0
Wed	26					7 37·1
Thur	27	8 38	Conjunction of Jupiter and Venus, 1° 19′ S.			7 33·2
Fri.	28					7 29·2
Sat.	29	1 55 14 11	Conjunction of Moon and Saturn, 3° 55′ N. Conjunction of Moon and Mercury, 2° 6′ N.			7 25·3
Sun	30	3 28	New Moon Eclipse of the Sun—invisible in England			7 21·4
Mon	31					7 17·4

TABLE OF REFRACTION.

This Table, calculated to half minutes of arc, gives the correction to be added to the True, or subtracted from the Apparent, Altitude of the object.

Altitude of the Object.	*Refraction.*	*Altitude of the Object.*	*Refraction.*
1° 1′ to 1° 5′	24′	4° 1′ to 4° 15′	11½′
1 6 ... 1 10	23½	4 16 ... 4 30	11
1 11 ... 1 15	23	4 31 ... 4 45	10½
1 16 ... 1 20	22½	4 46 ... 5 5	10
1 21 ... 1 25	22	5 6 ... 5 25	9½
1 26 ... 1 30	21½	5 26 ... 5 50	9
1 31 ... 1 35	21	5 51 ... 6 15	8½
1 36 ... 1 40	20½	6 16 ... 6 40	8
1 41 ... 1 45	20	6 41 ... 7 10	7½
1 46 ... 1 50	19½	7 11 ... 7 50	7
1 51 ... 2 0	19	7 51 ... 8 30	6½
2 1 ... 2 5	18½	8 31 ... 9 20	6
2 6 ... 2 10	18	9 21 ... 10 0	5½
2 11 ... 2 15	17½	10 1 ... 11 30	5
2 16 ... 2 20	17	11 31 ... 12 30	4½
2 21 ... 2 30	16½	12 31 ... 14 30	4
2 31 ... 2 35	16	14 31 ... 16 30	3½
2 36 ... 2 45	15½	16 31 ... 20 0	3
2 46 ... 2 55	15	20 0 ... 23 0	2½
2 56 ... 3 5	14½	23 0 ... 29 0	2
3 6 ... 3 15	14	29 0 ... 38 0	1½
3 16 ... 3 25	13½	38 0 ... 53 0	1
3 26 ... 3 35	13	53 0 ... 76 0	0½
3 36 ... 3 50	12½	76 0 ... 90 0	0
3 51 ... 4 0	12		

FOR ALTITUDES LESS THAN ONE DEGREE.

0′ to 1′ .... 34½′	13′ to 15′ .... 31′	34′ to 36′ .... 27½′
1 - 2 34	16 - 18 .... 30½	37 - 39 27
3 - 4 .... 33½	19 - 21 30	40 - 42 .... 26½
5 - 6 33	22 - 24 .... 29½	43 - 46 26
7 - 8 .... 32½	25 - 27 29	47 - 50 .... 25½
9 - 10 32	28 - 30 .... 28½	51 - 55 25
11 - 12 .... 31½	31 - 33 28	56 - 60 .... 24½

INSTRUMENTS, &c., FOR SALE.

These Notices, which are restricted to *three lines* each, are inserted free of charge to subscribers: applications respecting prices and other particulars to be made to the Editor, with a stamped envelope for reply, without which *no answer can be sent.*—For Advertisements with prices and more complete details, a small charge will be made.

Equatoreal Telescope, 5½ ft. focus, 4⅜ in. aperture, powers 60, 340, and 450, on extra stout mahogany tripod stand, steadying rods, levels, large finder, &c., complete. [18]

Astronomical Refractor, focal length 4 feet, aperture 3⅜ inches, complete, on a Portable Universal Equatoreal Stand. [3]

Achromatic Refractor, 44 in. focus, 3½ in. aperture, on a Fraunhofer's Universal Equatoreal Stand. [7]

Achromatic Refractor, 4 ft. 6 in. focal length, 3½ in. aperture, by *T. Cooke & Sons,* Equatorially mounted, on tripod stand. [36]

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INSTRUMENTS, &c., WANTED.

Equatorial Stand, Wanted—adapted for a 5 ft. Refractor, with graduated circles; second hand, at a moderate price. [35]

Monthly Notices of the Royal Astronomical Society.—The third Volume wanted: a good price will be given. [26]

THE PULKOVA OBSERVATORY.

On the 18th of August last was celebrated the twenty-fifth anniversary of the inauguration of the Central Observatory of Russia, and astronomical celebrities from many countries assembled to pay a tribute of respect to its projector, the world renowned W. Struve. The observatory at Pulkova is the intellectual centre of all the geodetical work of the empire, to promote which a High School of Geodesy, Military Surveying, and Navigation, has been established in connection with it. After M. Struve's opening speech, his distinguished son, M. Otto Struve, the director of the observatory, said that he hoped for a continuance of the sane cordial co-operation which had hitherto existed between Pulkova and the astronomical establishments of other nations: he adverted to the English astronomers and the Royal Astronomical Society of London, as displaying great zeal in promoting the science, and particularly expressed how much he felt indebted to Professor Airy for his assistance. Professor Hansen of Gotha, Mr Warren De La Rue, M. Claussen, Dr Bruhns, Dr Förster, Dr Schönffeld, and others also, addressed the meeting, which was followed by a visit to the observatory, and a grand evening banquet at St Petersburgh.

CORRESPONDENTS' QUERIES.

Can any of your learned readers inform me to what point in space the axis of Mars is directed, or where the plane of his equator intersects that of the ecliptic? Neither are given even approximately in any work I have consulted, and the direction of the former or place of the latter would be very useful in observing the rotation at the ensuing opposition.

W. L. B.

LIST OF SUBSCRIBERS.

NAMES RECEIVED SINCE OUR LAST NUMBER.

Buck, J. Esq., High Street, Aldborough, Suffolk.
Grover, Charles, Esq., Red Lion Street, Chesham, Bucks.
Hibbert, G. Esq., Mark House Lane, Walthamstow, Essex.
Pieraggi, Signor E., 14, Grove Road, St John's Wood, N.W.

ASTRONOMICAL REGISTER:

SUBSCRIPTIONS RECEIVED BY THE EDITOR FOR 1864.

To June.	To September.	To December.
Barneby, T.	Hibbert, G.	Broughton, S.

Notices to Correspondents.

Communications received from Evan Hopkins and "Cyclops."

The Moon Controversy.—Mr Perigal intimates that upon the appearance of the conclusion of Mr Dawes' letter he will reply to it.

The Astronomical Register *is intended to appear at the commencement of each month: the Subscription (including Postage) is fixed at* **Three Shillings** *per Quarter, payable in advance, by postage stamps or otherwise.*

The pages of the ASTRONOMICAL REGISTER *are open to all suitable communications: Letters, Articles for insertion, &c., may be sent to the Editor*, MR S. GORTON, Stamford Villa, Downs Road, Clapton, N.E., **not later than the 20th of the month.**

The Astronomical Register.

No. 23. NOVEMBER. 1864.

SPECTRUM ANALYSIS OF THE STARS AND NEBULÆ.

IN THE *Astronomical Register* for April and May, 1863, will be found notices of the earliest discoveries with respect to the Stellar Spectra, including an account of the first communication by Mr. Huggins and Dr. Miller to the Royal Society, and of the observations of the Astronomer-Royal, with a reference to papers by Rutherfurd and Secchi on the same subject. In the number of the *Register* for April, 1864, we again adverted to the subject, and showed the importance attached to it by quoting the remarks of the President of the Royal Society in his Annual Address. At the same time, we mentioned that Mr. Huggins had then lately read another paper to the Royal Society, which was subsidiary to his former one, and was devoted to recording the results of an examination of the spectra of the principal metals, and the measurement and mapping of the lines they produce, as he found the maps of other physicists not sufficiently elaborate for his purpose.

This necessary digressive operation having been performed, Mr. Huggins resumed his labours on the celestial bodies, and in conjunction with Dr. Miller, on the 26th May last, communicated to the Royal Society another paper on the results of their examination of nearly 50 fixed stars. Our readers are, doubtless, familiar with the essential parts of spectroscope apparatus, and it

is, therefore, only necessary to mention that in the arrangement adopted by Mr. Huggins two prisms of dense flint glass, with the proper collimator and observing telescope, are adapted to the eye-end of his magnificent telescope of eight inches aperture and ten feet focal length, so that the object-glass, which is a remarkably fine one, by Alvan Clarke, forms a powerful condenser of the light of the distant luminaries. In their early researches, our observers measured the distance of the spectral lines from one another, and from the standard of their scale by micrometric apparatus; but the labours of Mr. Huggins on the metals taught him the risk of relying on small measured differences, which might be due to variations of temperature and other derangements of the apparatus, and he therefore conceived the idea of exhibiting the spectra of the metals in the same field of view with the stellar spectra, and only allowing the identity of the lines when absolute coincidence was proved. The paper contains diagrams of the spectra of Aldebaran and α Orionis, and tables of the measures of the lines in these stars and of β Pegasi.

About 90 lines in Aldebaran, nearly 80 in α Orionis, and 15 in β Pegasi, have been carefully ascertained, and the spectra of between 40 and 50 stars more or less completely measured. The diagrams include the results of the direct comparison of the spectra of various terrestrial elements with those of the stars. In the spectrum of Aldebaran, coincidence with nine of the elementary bodies was observed—viz. sodium, magnesium, hydrogen, calcium, iron, bismuth, tellurium, antimony, and mercury. In seven other cases, no coincidence was found to occur.

In the spectrum of α Orionis five cases of coincidence were found—viz. sodium, magnesium, calcium, iron, and bismuth; whilst in the case of ten other metals no coincidence with the lines of this stellar spectrum was found.

β Pegasi furnished a spectrum closely resembling that of α Orionis in appearance, but much weaker: only a few of the lines admitted of accurate measurement for want of light; but the coincidence of sodium and magnesium was ascertained; that of barium, iron, and manganese was doubtful. Four other elements were found not to be coincident. In particular, it was noticed that the lines C. and F., corresponding to hydrogen, which are present in nearly all the stars, are wanting in α Orionis and β Pegasi.

The remaining stars in the list have not been so completely investigated, but several points of much interest have been ascertained.

The spectrum of *Sirius* contains five strong lines and numerous finer ones. The occurrence of sodium, magnesium, hydrogen, and probably of iron, was shown by coincidence of certain lines in the spectra of these metals with those in the star. In *α Lyræ* the occurrence of sodium, magnesium, and hydrogen was also shown by the same means. In *Capella* sodium was shown, and about 20 of the lines in the star were measured. In *Arcturus* about 30 lines were measured, and the coincidence of the sodium line, with a double line in the star spectrum, observed. In *Pollux* evidence of the presence of sodium, magnesium, and probably of iron, was obtained. The presence of sodium was also indicated in *Procyon* and *α Cygni*.

In no single instance was a star spectrum found in which lines were not discernible, if the light were sufficiently intense, and the atmosphere favourable. Rigel, for instance, which some authors state to be free from lines, is filled with a multitude of fine lines.

Photographs of the spectra of Sirius and Capella were taken upon collodion; but, though tolerably sharp, sufficient experiments in this direction have not been made to obtain any indication of lines in the photograph: but the fact of procuring such photographs at all is in itself something wonderful, and the lines will, no doubt, hereafter be secured.

The Moon, and planets Venus, Mars, Jupiter, and Saturn, have been examined, and the coincidence of the principal lines of their spectra with those of the Sun's spectrum ascertained, proving their light is reflected from that luminary. In the case of the Moon, no difference could be perceived at any time, showing, in accordance with astronomical observations, that our satellite has little or no atmosphere; but with the planets there were indications of specific lines, which showed atmospheres surrounding them similar to our own gaseous envelope.

It must not be forgotten that, so far as we know, Mr. Huggins and Dr. Miller are the only observers who have applied the method of direct comparisons and coincidences of the stellar and metallic spectra—a method far surpassing all others in accuracy, and, considering the results, trustworthy to an extent which no measures

can pretend to, and we trust the beginning thus made may be followed up by continued progress. Indeed, we may state that Mr. Huggins, far from being idle since the paper we have been abstracting was read, has been engaged in researches on the spectra of the nebulæ, the fruits of which are of the most interesting character, and tend to prove conclusively that the constitution of *some at least* is truly gaseous or vaporous, and that the generalisation of considering all these bodies as clusters of stars must be given up, and the existence of nebulæ proper thoroughly admitted. We trust it will not be long before we may resume the subject, and give these results more in detail.

T. W. B.

THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE—ASTRONOMY.

In our last number we were unable to give more than a brief notice of the meeting at Bath. The following is a more detailed account of what took place:—Eleven papers on astronomical subjects were presented to and read in the Mathematical and Physical Section of the Association. Of these, two had relation to the physical aspect of the Sun; five to the Moon; two to the planets Mars and Jupiter. The paper on Jupiter also related to the spectra of double stars and nebulæ. A paper, entitled "*Speculations on Physical Astronomy,*" was announced, and the able report on Luminous Meteors, which may be regarded as a valuable contribution to Meteoric Astronomy, completed the series of astronomical papers.

The papers on the Sun were by Professor Phillips and the Rev. W. R. Dawes. Of the former, which was of a very valuable character, we may probably give an abstract in a future number. That by the Rev. W. R. Dawes treated on the present aspect of the "*'Willow-Leaf' Controversy,*" and the author endeavoured to show that the appearances on the solar surface, which had respectively been termed "willow-leaves" and "rice grains," were not new discoveries, but had been seen by Sir William Herschel at the close of the last century, and recognised by the author many years since. Sir W. Herschel termed them "self-luminous clouds," and the Rev. W. R. Dawes entitled them "granulations."

Of the five papers on the Moon, two referred to the subject of change on its surface; one to nomenclature; one to the invisible portion of the moon; and one to lunar photography. The two on change were by the Rev. T. W. Webb and W. R. Birt, and the one on nomenclature was by Dr. Lee, who described an extensive plain west of the Montes Hercynii, which he proposed to name "Otto

Struve." These papers we hope also to notice more at large. The Rev. T. W. Webb read a paper on the invisible part of the moon, in which he alluded to the deduction of Hansen, that the centres of figure and gravity of the moon were not coincident, and that, consequently, the part of the moon turned away from us may possess an entirely different constitution to that which obtains on the portion which is visible to us. An interesting discussion succeeded the reading of this paper, in which the President of the Section, Professor Cayley, and Professor Price took part, both urging that Hansen's views were founded purely on mathematical data, and were not generally received by mathematicians. It was also stated that Professor Adams disagreed with the conclusions at which Hansen had arrived. Mr. Brothers exhibited two enlarged photographs of the moon, from a negative by De la Rue, at a period of its illumination shortly after the first quarter. His object was to show that, by a process which he employed, he was able to print the enlarged copy *at once*, and not in sections, as had been the case previously. The photographs exhibited were illustrative of his remarks, one having been printed in two sections, and afterwards joined, and the other consisting of a single sheet of paper. Both copies were very beautiful, the irregularities in the neighbourhood of the terminator being brought out with great distinctness. We particularly remarked how strikingly the high land in the neighbourhood of Tycho was shown, producing quite a protuberance on the southern part of the terminator.

The paper on the planet Mars, by Professor Hennessy, related to the high ellipticity which is generally assigned to the planet, the result of this high ellipticity being a greater distribution of land in the equatoreal regions, and of water in the polar regions, of Mars. Professor Hennessy alluded at some length to the results arrived at by Bessel and Johnson, the observations of the former having been fully discussed by Oudemanns in the *Astronomische Nachrichten*, No. 838, p. 352. Johnson discussed in the *Radcliffe Observations* for 1850 and 1853 the measurements made with the heliometer at Oxford, and arrived substantially at the same result—namely, that the observations gave varied and uncertain values for the equatoreal and polar diameters, and therefore that it was permissible to regard the planet as approximately spherical. Professor Hennessy also remarked that the mass of brilliant matter in the neighbourhood of one of the poles of Mars analogous to terrestrial snow would probably, and that very seriously, interfere with the accuracy of telescopic measurements, owing to the irradiation of such an extremely bright object; and further, that the *excentricity* of this snowy patch might greatly affect any results, unless great caution were used in deducing them. From certain mathematical expressions which Professor Hennessy had obtained, based on a mechanical theory both simple and certain, the Professor concluded that, if the ellipticity of Mars were small, there would result two large continents surrounding either pole, with an intermediate equatoreal belt of water. On the other hand, were the ellipticity great, the planet would be distinguished by an equatoreal belt of land intermediate between two polar basins, in which the waters would be collected. From the drawings appended to Mr. Lockyer's paper in the *Memoirs of the Royal Astronomical*

Society, Professor Hennessy considered that no preponderance of land in the equatoreal regions of Mars exists, and that if the appearances of its surface are due to the presence of a liquid, the values of the ellipticity assigned by Bessel and Johnson are nearer the truth than those of other observers. In the discussion that followed, the Rev. T. W. Webb remarked that his impression was, that more land existed in the neighbourhood of the equator of Mars than water. If so, Professor Hennessy remarked, we should be justified in assigning a high ellipticity to the planet, and not so high a value to the results of Bessel and Johnson.

The spectrum of the planet Jupiter, spectra of certain double stars, and also of certain nebulæ, formed the subject of a most interesting paper by Mr. Huggins and Dr. Miller, for which we refer our readers to the first article in this number.

The title of the paper, "*Speculations on Physical Astronomy,*" by R. W. Hardy, was merely announced, and the report on luminous meteors we hope to give an abstract of in a future number.

The above chronicles the Astronomical proceedings of the Mathematical and Physical Section of the Association. We now turn to the assistance which the Bath Meeting has extended to astronomical science in the shape of two grants of money—one for the registry of objects on the lunar surface, the other for the registry of luminous meteors. The grant for lunar objects may be regarded as purely astronomical; that for luminous meteors as, at present, connected with meteorology, as the objects are visible within the confines of our atmosphere. James Glaisher, Esq., is appointed the chairman of both committees. The resolution proposing the committee for the registration of objects on the Moon's surface is as follows:—

"That James Glaisher, Esq., Lord Rosse, Rev. T. W. Webb, W. R. Birt, Esq., Dr. Lee, J. N. Lockyer, Esq., Rev. W. R. Dawes, Sir J. Herschel, Bart., Professor Phillips, J. Nasmyth, Esq., Warren De la Rue, Esq., and H. S. Ellis, Esq., be a committee, with power to add to their number, for the purpose of preparing forms for registering the various craters and visible objects on the Moon's surface, and for constructing an outline map of four times the scale of that of Beer and Mädler's, according to the plan proposed by Mr. Birt, and also for conducting an extensive correspondence with philosophers on the subject."

"That James Glaisher, Esq., be the chairman of the committee, and W. R. Birt, Esq., be the secretary, and that the sum of £35 be placed at their disposal for the purpose."

The Committee on Luminous Meteors and Aerolites, consisting of Mr. Glaisher, Mr. R. P. Greg, Mr. E. W. Brayley, and Mr. Alexander Herschel, was re-appointed, and the sum of £40 placed at their disposal.

Constitution of the Sun.—Mr. De la Rue, Mr. Balfour Stewart, and Mr. Loewy, are understood to be engaged in some important investigations with regard to the solar physics, upon views partly derived from the Kew photographs, and partly from other considerations. Mr. Carrington has placed his seven years' observations at Red Hill at their disposal.—*Athenæum.*

NOTES AND GLEANINGS.

Comet iii. 1864.—The following elements of the comet whose discovery was mentioned in our last number are by M. Celina, of Milan:—

P.P.=1864, July, 27·8829.
π=190 10.
☊=175 11.
$\angle$=44 56.
Log. q=9·787184.
Heliocentric motion—Retrograde.

The Comet visible to the naked eye in August last (heretofore No. i. of the year, but now ii., in consequence of the discovery of another, which passed perihelion in July) is described by M. Schmidt, of Athens, as 32′ in diameter on August 5, and with a tail "which must have been 30° or 40° long." We should be glad to receive communications on this point from any of our readers who may have observed the comet, for these dimensions, as regards the tail, greatly surpass any which have yet come under our notice.

A New Minor Planet was discovered by M. Tempel at Marseilles on September 30. Its position at 8h. M. M. T. was—

R.A. 0h. 16m. 35s.
Decl. +2° 48′

On October 3, its position was—

R.A. 0h. 13m. 50s.
Decl. + 2° 59′.

It shines as a star of the 10th or 11th magnitude.

A New Micrometer Head has been devised by Mr. Royers, one of the assistants at the Washington Observatory, for enabling several bisections of a star to be made without the necessity of reading the circle after each bisection. He uses, in addition to the ordinary divided circle, two others, side by side, concentric with the chief one, and placed between it and the milled head. The 3 circles do not quite touch one another, but, between them, index arms revolve on the axis.

Spectrum of a Comet.—With No. 1488 of the *Astron. Nach.* is presented a diagram of the spectrum of Comet iii. of 1864, drawn by M. Donati. It contains 3 bright bands, nearly equidistant, and of nearly the same breadth. The middle one lies between the lines F and *b* of the solar spectrum.

The Variability of δ Libræ is announced by M. Schmidt. The period seems to be about 7·3 days, and the range from 4½ to 6 mag. M. Schmidt states that he first suspected that the light of this star was not uniform in April, 1859.

Twilight.—A lengthy and important memoir on Twilight will be found in the *Ast. Nach.* for October 14, 1864. It is from the pen of M. Schmidt, of Athens.

The New Planet has, at the suggestion of M. Peters of Altona, been named *Terpsichore.*

New Variable Star.—Mr. Baxendell announces the discovery of a new variable star in Delphinus. Its approximate place for 1860 is—

R.A.				Decl.	
H.	M.	S.		°	′
20	38	51·9	...	+15	53·5

The star was first noticed on October 24, 1863, being then of mag. 8·6. By December it had fallen below mag. 12. After conjunction with the sun, it was found on July 29, 1864, as a 13th mag.; and between that date and Sept. 5, it rose to mag. 8·4. Mr. Baxendell calls attention to the singular fact, that there is an apparent tendency in variable stars to occur in groups.

Stellar Chartography.—An invention promising to work a revolution has recently been set to work at the Dudley Observatory, Albany F.S.A., by Mr. G. W. Hough. This gentleman has contrived an arrangement of mechanism for puncturing on sheets of paper the places of stars, which are in fact fac-similes of the heavens. A full description appears in *Silliman's Journal* for September.

Royal Observatory, Edinburgh.—The twelfth volume of the *Edinburgh Astronomical Observations* contains the principal observations made under the direction of Professor C. Piazzi Smyth from 1855 to 1859. In addition to the daily record of work done by the transit and the mural circle, the Teneriffe experiment of 1856 is referred to, and the observations then and there made given. The arrangements also for firing the time-gun at Edinburgh by electricity are fully described. On the whole the volume, as a record of very valuable work performed, is a welcome addition to our astronomical libraries. It is illustrated with wood engravings and photographic views.

CORRESPONDENCE.

LUNAR PHYSICS.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—May I take the liberty of acknowledging the receipt of the following suggestion and query through the medium of your columns?

Sept. 15, 1864. Section A.

Papers read by the Rev. T. Webb and W. R. Birt, Esq.

Suggestion.—That the most reliable evidence as to the supposed changes of the moon's surface would be obtained from a number of series of selenographs. Each series to consist of a succession of photographs, to be taken at considerable intervals of time, and, as far as

possible, with the same telescope and the same lunar positions, both as regards earth and sun.

This would furnish positive data for future ages, free from all errors of observation, whether arising from want of care, or from those peculiarities of judgment and eyesight to which the most eminent astronomers are liable.

Query.—Are the supposed alterations on the moon's surface all additions to former maps, admitting the hypothesis of their being entirely due to better instruments or more careful observation? Or has any marking recorded in former years become imperceptible of late?

J. W. B.

The writer of the above not having furnished his name or address, I have, on behalf of myself and the Rev. T. W. Webb, been unable to reply by letter; but I take this opportunity of remarking that the suggestion is very valuable, and that series of selenographs, taken as proposed, would very greatly assist in the formation of a catalogue such as I have in hand. At present my materials consist of the earlier delineations of the moon's surface, including the valuable series contained in the two volumes of Schröter's "Fragmente Selenotopographische;" the large Map of Beer and Mädler, the now acknowledged authority on lunar matters; Lohrmann's Map of the Moon, of about 15 inches in diameter, and his four sections, which embrace a considerable portion of the central regions of the moon. The features recorded by these authorities are very carefully checked by personal observation with two telescopes, viz. the Hartwell Equatorial of 5·9-inches aperture, and the Royal Society's achromatic of 4·25-inch aperture, object-glass by Cooke and Sons of York, the telescope and mounting having been constructed for this especial work by Messrs. Smith, Beck, and Beck, of Cornhill, under the immediate superintendence of Warren De la Rue, Esq.: and in addition to the above authorities, it is not unlikely that I may be able to obtain permission to examine microscopically the valuable series of lunar negatives taken by Mr. De la Rue, which will greatly add to the value of the catalogue.

May I be permitted to remark, that I shall at all times be most happy to receive communications relative to lunar physics, as appertaining to the configurations of the moon's surface, delineations of craters, or other interesting features, especially *minute* objects, and on any topics that may be likely to advance the work I have on hand.

I am, Sir, your obedient servant,

W. R. BIRT.

Victoria Observatory, Victoria Park, London, N.E.:
September 26, 1864.

SILVERED GLASS REFLECTORS.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—In the system of ϵ Lyræ (that is, between ϵ and 5), to the south of Sir J. Herschel's "debilissima couple," and just to the S. of

the southernmost of them, I see two more stars, much fainter still, the existence of which, I believe, has not yet been pointed out. They form an isosceles triangle with the southernmost of the "couple." The preceding is much the fainter of the two. I see them with my silvered glass 12-inch Newtonian easily, with a 10-inch aperture. I should be glad to know with how small an aperture they can be seen in a good achromatic, as it would afford a good test of the relative illumination of the achromatic and the silvered glass reflectors.

I am, Sir, yours truly,
HENRY COOPER KEY.

Stretton Rectory, Hereford:
Oct. 22, 1864.

ACHROMATIC OBJECT-GLASSES.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—Will any of the practical readers of the *Astronomical Register* give an account of the manipulations or of the machines for giving a true spherical figure to, and polishing, Achromatic Object-Glasses; in something after the same manner that the Rev. H. C. Key has done in his account "Of a mode of figuring glass specula for the Newtonian Telescope," published in vol. xxiii., page 199, of the *Monthly Notices of the Royal Astronomical Society*? There was an animated discussion on this subject at the last meeting of the above Society, and it is a subject of great importance to astronomers.

Yours truly,
WM. SHAWCROSS.

Heaton Norris: Oct. 12, 1864.

THE VARIABLE STAR η ARGUS.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—I have received from Lieutenant Tupman, of the Royal Marine Artillery, the following letter, which I am permitted to publish in your pages:—

"Looking over your excellent and useful list of variable stars, I see η Argus put down as varying from 1 mag. to 4th in forty-six years. Whatever may be thought of the period assigned by Prof. Wolff, there is no doubt that the 4th mag. does not represent its minimum. During 1863 it was just visible to the naked eye, getting dimmer very slowly throughout the year; and during the first six months of 1864 it was invisible to all but the finest eyes.

"You invited *corrigenda* of a trustworthy character; and as I have taken particular notice of the star, and have made many 'sequences' containing it, I thought you would be glad to hear this."

There are few objects in the southern hemisphere standing more in need of careful and prolonged observation than η Argus and the nebula surrounding it. Not only does great uncertainty hang over the

movements (so to speak) of the star, but the question of changes in the contour of the well-known vacuity in the nebula pointed out by Mr. Powell demands serious attention.

I am, Sir, your obedient servant,

October 19, 1864. GEORGE F. CHAMBERS.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—In reply to the enquiry of your correspondent W. L. B. with respect to the planet Mars, I beg to state that Sir W. Herschel communicated to the Royal Society the following data, which are to be found in the Philosophical Transactions for 1784, and which have been assumed by MM. Beer and Mädler, in their memoir, published in 1841:—

"The axis of Mars is inclined to the ecliptic 59° 42′.

"The node of the axis is in 17° 47′ of Pisces.

"The obliquity of the ecliptic is 28° 42′.

"The point Aries on the Martial ecliptic answers to our 19° 28′ of Sagittarius."

Hoping that this information may answer your correspondent's purpose, and that many observations may be made upon the planet at an opposition which is, I believe, more favourable than many subsequent ones,

I remain, Sir, yours faithfully,

T. W. WEBB.

Hardwick Parsonage, Oct. 19, 1864.

[We have prepared a diagram for the planet Mars, similar to that which was arranged last year for Jupiter. Copies are now ready, and will be forwarded by the Editor to those Subscribers to whom it may be useful in making sketches of the planet, on his receiving a note from them to that effect.—Ed.]

MERIDIONAL v. *MERIDIANAL.*

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—Is your correspondent G. J. W. correct in his derivation of meridi*o*nal from meridianus? On consulting White and Riddle's Latin Dictionary, I find, besides meridianus, a later form, meridionalis. If G. J. W. prefers the form meridi*a*nal, by all means let him use it; but I think he must allow, unless he is a severe classic, that the form meridi*o*nal, as derived from meridionalis, is, at least, equally correct.

G. K.

MERIDIANAL v. *MERIDIONAL.*

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—Your correspondent G. J. W., in the last number of the *Register*, brands Sir John Herschel and myself as being "guilty" of

writing *Meridional* instead of *Meridianal*; and, as I am likely to persist in thus sinning, I'll e'en tell him why.

The term was originally adopted from the French, and has long been naturalised into the English language by time and custom; so that it has become an authorised vocable. As such it was used by Jonas Moore, Halley, Oughtred, Wright, Robertson, *et hoc genus omne.* The word will be found in Johnson's Dictionary, where it is illustrated from Sir Thomas Browne's "Vulgar Errors;" and other lexicographers treat of it. From very early youth I have referred to the tables of Meridional Parts in our navigation books, as well for the easting or westing of a day's work, as for constructing charts on Mercator's projection. Moreover, it has long been bandied in common parlance.

So much for myself. As to Sir John Herschel, he is quite sufficient —both as a profound scholar and practical philosopher—to constitute a sound warrant in such a question.

Yours faithfully,
W. H. SMYTH.

St. John's Lodge, near Aylesbury: 10–10–64.

BRIGHT SPOT ON THE MOON.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—I would call the attention of your readers to a remarkably bright spot in the "Mare Crisium."

Last night I turned my telescope on the moon (which was very bright for a short time), and perceived a little to the W. of Picard a spot of about 6° or 7° of brightness. Now I have very often observed the "Mare" before, often very attentively, but have seen nothing of the kind, except on May 15, 1864, when, the moon being about the same age as last night, I saw this same spot. The whole of the "sea" appeared also very much broken up with light and shade.

I may say that the "Mare Crisium" was brought well into view by libration of the disc, which may have had the effect of bringing this spot to light.

Hoping this will meet the eye of some one more capable of judging than myself,

I am, Sir, yours obediently,
HERBERT INGALL.

Camberwell: Oct. 17, 1864.

P.S. I saw β Capricorni within two minutes of the time of occultation, but clouds intervened at the moment of disappearance. I hope fortune favoured you better.

[Unfortunately, no.—Ed.]

THE PLANET MARS.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—I beg to submit to your querist, "W. L. B.," the following extracts from a few authorities at hand:—

"The planet revolves on an axis inclined at an angle of 59° 27′ to

the plane of the ecliptic, or 61° 18′ to the plane of his orbit."—(*Arago, Pop. Astron.*, by Smyth and Grant, vol. ii. p. 474.)

"The orbit of Mars is inclined to the earth's orbit, or ecliptic, at an angle of 1° 51′ 6″."—(*Manual of Astron., Galbraith & Houghton*, p. 119.)

"Sir W. Herschel found that the axis of Mars is inclined to his orbit at an angle of 61° 18′, or 59° 42′ to our ecliptic, *the north pole being directed to longitude* 347° 47′. The obliquity on the globe of Mars is, therefore, 28° 42′."—(*Hind, Solar System*, p. 78.)

I am, Sir, your obedient servant, G. W.

Upper Holloway: Oct. 15, 1864.

THE FOUCAULT PENDULUM EXPERIMENT.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—Might I be allowed to thank A. Bird for so promptly supplying the desired information, with so much minuteness, on the pendulum experiment? I hope it may be useful to some who may wish, and have the convenience, for carrying it out; but if 45 feet in height be a *sine quâ non* of success, am sorry to say I must necessarily abandon its further prosecution, not having a suitable room with more than 15 feet in height, and 17 feet for range of oscillation on the meridian, although I have one, not quite so convenient, 24 feet high. I had procured a hank of Japanese silk, as wound from the cocoon, of which to make the suspender, brought to the requisite strength by reduplication, or otherwise to cover one or both ends of the steel wire with it, thinking this would meet the requirements of that part of the case.

I am, &c.,

Skipton: 10–10–64. T. W.

Sir,—Is not the idea that the pendulum experiment proves the rotation of the earth now all but exploded as a mistake? When the pendulum is made to vibrate east and west in the equator, at Singapore, it varies its direction precisely the same as in high latitudes: this alone would seem to prove that the variation has nothing to do with the rotation of the earth. The fact would seem to be that our surrounding atmosphere and the terrestrial magnetic power are so bound and braced together with our earth, that sublunary objects cannot be sensitive of the rotation of our planet.

Yours, &c.,
F. G. S.

DAYLIGHT OBSERVATIONS OF CELESTIAL OBJECTS.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—It has sometimes occurred to me that a statement, with some details, of what may be done in the way of observation by day of celestial objects, with somewhat limited instrumental means in point of size (a good 4½-inch equatorial), might interest and stimulate

a sufficient number of incipient telescopic observers, without being irksome to the generality of readers of the interesting pages of the *Astronomical Register*, to make it worth while to give it insertion; and after much hesitation on that account (seeing the subject hinted at in No. 21 by a most valuable contributor, the Rev. W. R. Dawes), I have now resolved to forward the enclosed extracts from my observatory journal, in case they, or any part of them, should be deemed suitable for publication, with the recollection that they are necessarily and very properly submitted to competent and judicious editorial scrutiny and decision as to fitness.

To facilitate day observations, of the finer class of objects especially, I have small slips of mahogany always at hand, labeled, the length and breadth of which show how far the two tubes of the telescope must be drawn out to ensure at once the proper focus, more particularly with the lowest power of the ordinary eye-piece and micrometer eye-piece respectively.

Although this day-work may not admit of very extensive utilisation, yet it affords to the tyro amateur a most agreeable and exciting recreation, and the degree of expertness imparted by it in setting the circles, acquired in good daylight, genial temperature, and without the annoyance seemingly more or less inseparable from artificial illumination, will be duly appreciated in the rigorous evenings of winter. The taking of transits also, by day, has the same advantages, and there are always stars eligible for the purpose.

I am, &c.,

Thornton-in-Craven: 10-10-64. T. WILSON.

Objects observed by T. W. in broad daylight, with $4\frac{1}{4}$-inch equatorially mounted refractor, by T. Cooke and Sons, many of them at and near noon.

93 of the 147 clock stars of the Nautical Almanac, 19 of which are between the 3rd and 5th magnitude.

The following Double Stars, some of the most minute and difficult of the companions of which have been seen very near noon, and most of them frequently along with, and for the gratification of friends.

Principal and Comes of	Magnitude of Comes
ζ Ursæ Majoris	5
(And sometimes Alcor in the same field, power 54, angular diameter of field of view, 40′.)	
γ Leonis	4
θ^1 & θ^2 Tauri	5 & 5·5
η Tauri (Alcyone)	7
γ Andromedæ	5·5
α Herculis	5·5
β Cygni	7
61 Cygni (both, without any guiding-star)	5·5 & 6
α Piscium (both)	5 & 6

Micrometrical measurements of double stars are also practicable with near approach to accuracy, and I think might be quite so with a well-practised micrometrician. For instance—

June 23, 1863, I made the distance of the components of γ Virginis

$7''\cdot56$ (distance given in the Speculum Hartwellianum, by Adm. Smyth), the sun being 1h. 18m. above the horizon.

Oct. 5, 1864, at 3½h. P.M., made distance of β Cygni $33''\cdot9$ ($34''\cdot1$, epoch 1854).

Same day, at 3 P.M., made ζ Ursæ Majoris $14''\cdot5$ ($14''\cdot2$, epoch 1854).

The position angles of course can be taken equally well, if the comites are visible.

Mercury, seen at any time, at transit or about noon, does very well when it has sufficient elongation. In one instance it was observed when differing from the sun in A. R. by 39m. 52s.

Venus was seen within three days of last inferior conjunction, and was then a splendid object, and at 3h. 21m. after last superior conjunction, and I have no doubt whatever that it could have been seen equally well at conjunction if clouds had been absent. Only a light tinted shade was used on the eye-piece (powers 54 and 100), with which a *very small* arc of the sun's limb in the field is quite tolerable to the eye, and with which I quite believe Venus would be comfortably viewed if close to the sun's disc.

Mars at almost any time of the day, and *Jupiter* with belts, not far from noon.

Saturn and *Uranus* at sunset, a little before or after, with ample daylight for setting the circles with perfect ease; also the companion of Rigel (9th magnitude).

Transits also of stars of 1st and 2nd magnitudes; if the latter, not too near mid-day.

THE MOON CONTROVERSY.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

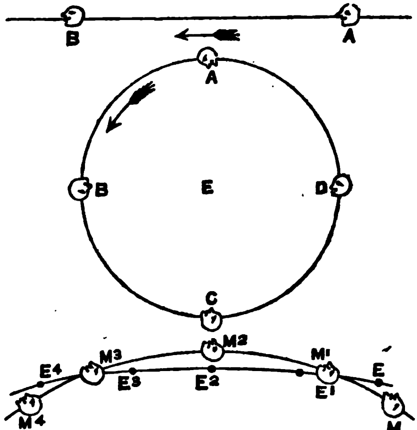
Sir,—"P" has certainly adduced what at least looks like a new argument. His illustration, and the reasoning he founds upon it, ought to be explained and answered, to satisfy him and those who think as he does. I don't agree with him, and don't wish to imitate what I consider his very careful ignoring of the strength of the argument on the side he differs from; but I shall leave him to "Cyclops" and others, while I endeavour to break new ground.

I am anxious to get at something like a *principle*, common to the cases of progression in a straight line or open curve, and "progression in a circle" or closed curve, when a body does not turn, and when it does turn, *in addition to* "progressing" in these respective paths.

The germ of the principle which I think might be adopted as unquestionable, was given in the illustration of "the fixed bayonet" in my letter in the *Register* for May. If a thing can't happen, it does not happen; if a body can't turn, it doesn't turn round. So much I assume.

If, then, we represent the moon as a round body, but (according to time-honoured tradition) as also having *a face*, we shall have a simple means of applying this principle as a test. I invoke "Cyclops," the Blind man ("Cui Lumen ademptum"), and "the man in the moon" himself,—and, *par excellence*, the Editor of the Astronomical

Register,—to give support to this earnest endeavour to *settle* the moon controversy.



Let A, then, be the moon — with a face — moving along the rod A B.

In that case, "following its nose," the moon progresses in a straight line, and *does not* turn on its axis; in fact, it *can't*, because the rod runs through it. The same half of the moon keeps always on the same side of the line or rod.

Now let us bend the rod A B into the circle or closed curve A B C D, which may now represent the moon's orbit round the earth; the earth, E, (for the nonce) being regarded as stationary. *The rod still passes through our moon,* dividing now its *face* from the invisible *back* which earthly eyes never see. Besides "progressing" (now in a circle, instead of, as formerly, in a straight line), the moon *can't* turn on its axis; *ergo*, I argue, it *does not* turn on its axis; Q. E. D., the rod passing through it makes turning simply impossible. It now only *revolves*, and, as before, *the face* always keeps on one and the same side of the rod (inside the orbit), the *back* always on the other.

But there is one more argument to answer. Our most enlightened philosophers don't believe the earth to be at rest, as above supposed for the sake of illustration. If it is a fact that the earth moves, let us stick to the fact.

In that case, if E E^1, E^2, E^3, E^4 represent the earth's path in a month (say, an arc of about 30°), then M, M^1, M^2, M^3, M^4 will represent (very rudely) the moon's path. If we stick the rod through her once more, *to keep her from turning,* the consequence is that she *does not* keep her face to the earth as she *ought to do,* and as the real moon does.

In order that her *face* may always look at the earth, it *now* must *turn round* as it "progresses;" it cannot slip along the rod.

If the Cambridge "Enquirer," "Cyclops," or Mr. Evan Hopkins, "H," or the "Engineer,"—nay, or any other man,—can get out of this dilemma, I shall sing his praises lustily. If we withdraw the rod that transfixes this *quasi* moon in her orbit (M M^1—M^4), and allow the lady *Luna* to make one quarter revolution between M and M^1, another between M^1 and M^2, &c., we shall then have the phenomena of her phases as they are on the heliocentric hypothesis, which we all say we believe. Then she will always look blandly upon us *with her face,* smiling as she very well may.

I am, Sir, your obliged servant,

Not "at Sea," July 19th, 1864. NAUTICUS

P.S. I need scarcely add, for those who think, that on the small

scale of the last figure (less than 1 inch to 10 million miles), the moon's path would not be discernible from the earth's, on the line E, E^1—E^4, I have exaggerated the moon's path only to make it visible, not to obscure or alter the argument or *principle* involved.

ON THE MOON'S ROTATION.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—Before proceeding to consider another aspect of the non-rotation theory as supported or illustrated by mechanical contrivances, I ought perhaps to bestow a few words on some objections already made to some part of my former letter, which you did me the favour to publish in the number of the *Astronomical Register* for September.

Your correspondent "An Enquirer," who writes from Cambridge, observes—"Mr. Dawes's argument, in proof that a man must necessarily be 'rotating because he becomes giddy,' will not bear criticism." If, however, the "Enquirer's" criticism is the most severe it will meet with, my argument will certainly not quail before it. As conclusively might he argue that, though a person rotating on his heel once in a second or two would become giddy, and his rotation might be reasonably inferred from his giddiness, yet if he rotated in the same way only once in five minutes, he would not become giddy, *and therefore he did not rotate at all!* The motions are in both cases *of the same kind.* So, whether he walks quickly round a small table, or round St. Paul's or London, there is in both cases a *combination of rotation with revolution*; and this is equally true whether the circle described be large or small, and whatever may be the relative angular velocity of revolution and rotation. Giddiness will not be produced by revolution alone, without rotation. I had, at first, some doubt whether "An Enquirer" could be serious in making such an objection; the frivolousness of the objection itself, and of the writer's style at the close of the same paragraph, combining to strengthen my doubts.

It is undoubtedly desirable to adhere to the most correct terms in describing different kinds of motion, and to restrict the term *rotation* to the wheel-like movement of *turning round* an internal axis; while *revolution* is employed to indicate, not "another way of *turning* round," as Mr. Perigal has called it, but *going round* an exterior centre, or performing an orbital movement round a central body. But it is of some importance to note that there is one kind or variety of rotation which has not been distinctly adverted to, and seems to have been overlooked, or confounded with revolution. I refer to *rotation with, or as a part of, a rotating body.* Thus, a tree, a mountain, or a house, *does not revolve round the earth,* but *rotates with it, and as a part of it.* When one of your correspondents, "Nauticus," grasps an orange at arm's length, and, holding it thus, turns round on his heel, he imagines that the orange *revolves round him,* and that this is a fair representation of the moon's revolution round the earth! Whereas, in fact, the orange is constrained to rotate with him, as a tree rotates with the earth, and in the same time as the other portions of the rotating body. And of the same kind is the fallacy introduced in mechanical contrivances professing to illustrate the moon's revolution

round the earth. They do not represent the facts of the case. The moon is not rigidly connected with the earth, and constrained to rotate with it in twenty-four hours; but revolves round it as a detached and independent body in her own elliptic orbit.

Yet even if she were rigidly attached to the earth, like a body fixed upon a horizontal wheel at some distance from its centre, it is not difficult to show that, even if she rotated along with the earth, she would be, while doing so, constrained to rotate round an internal vertical axis. One of the clearest and simplest modes of illustrating this is by placing a compass upon a horizontal wheel, and causing the wheel to rotate, the compass-card being fixed in its box, and the needle free to turn on the central point. The needle settles itself in the magnetic meridian. Now, if, before the wheel is put in motion, the compass-box be rotated under the needle, the needle continues in the same direction, and all the graduations of the card pass under it in succession. The card rotates, but the needle does not. Suppose the wheel to be now rotated in a *direct* sense—the side which is toward the north moving on toward the west: then N. upon the card (previously under the north end of the needle) is also moved with the wheel toward the west, while the needle continues parallel to itself and to the magnetic meridian. The *needle*, therefore, *does not rotate at all*, but the *card does*; and in the course of one rotation of the wheel, *the card and the central point have been constrained to make one rotation under the needle.* But, strange to say, we are told that it is the *needle* which has rotated, and *in the contrary direction.* Had this been the fact, the needle would not have continued parallel to the magnetic meridian, but its north end would have successively moved from the north point of that meridian through the east to the south, and so on. On the contrary, the whole effect produced upon the *needle* is simply this: *by its attraction toward the north, it has been prevented from rotating at all,* while the *card* has been *rotated under it.* The whole of the difference between this case and the former one (when the compass-box was rotated while the wheel was still) consists in this—that *the centre of rotation is in motion* along with the rest of the rotating wheel, but the fact of the rotation of the compass-box and the non-rotation of the needle is unaltered. And the necessary result of this is, that *the same side of the rotating card* is always turned to the centre of the wheel, while *every side of the non-rotating needle* is successively turned towards the same point. Now, in the mechanical contrivances which are intended to illustrate this subject, the same effect is produced on the moon's representative by mechanical means, as is produced on the needle by the steady attraction of its northern end towards the magnetic north; namely, *it is simply prevented from rotating at all*—whereas it has been represented as being *rotated in the opposite direction.* It seems strange that what appears to many to be a transparent fallacy, should with others assume the character of a certain truth.

The same facts may be well illustrated without any mechanical contrivances at all.—Take a compass, constructed as described above, and grasp the box with the right hand over it. If you are facing the magnetic north, the thumb will be toward the west point of the card, and the fingers on the other side. If you rotate your hand and the box in a *direct* sense, your thumb turns *towards* you, or from W. to S.;—if in a

retrograde sense, it turns *from* you, or from W. to N.—Now, in the first place, keep your hand from rotating at all, N. on the card continuing under the north end of the needle, and your thumb at W.; and carry the compass by the motion of your arm round any central object, thus representing an orbital revolution round it. In doing so, you will present every side of the card successively to the centre of revolution, because the card *revolves without rotating*. Now, in the second place, make the card revolve round the central body as before, but cause the card to rotate in a direct sense by turning your thumb, and W. on the card, toward yourself, so that one quarter of a revolution and one quarter of a rotation should be performed *in the same time*. In this way, the same part of the card will be always toward the centre, and the simultaneous and equi-angular revolution and rotation of the moon will be correctly represented. But if, while you carry the compass through one-fourth of its *direct* revolution, you rotate it in an opposite or retrograde sense, by turning your thumb from you, or from west to north, you will have presented *one-half* of the card's circumference to the central body; and if your hand could continue its rotary motion throughout a whole revolution, every side of the card would be turned toward the centre *twice* in the course of one revolution.

There can surely be no ambiguity respecting what constitutes *rotation*. If a body in a state of rotation is viewed in the direction of its axis of rotation, every point on its visible surface is seen to describe a circle round that axis. This is the necessary consequence of its rotation, and is therefore a conclusive proof that the body is rotating. Now, let us suppose a spherical body stationary in space but rotating round a vertical axis, and at the rate of once in *five* minutes. Let it then begin to revolve round another body as a centre of a circular orbit, its rate of rotation being unaltered. If its revolution is performed in *six* minutes, it is evident that its rotates on its axis in *less* time by one minute than is consumed in its revolution. If it revolves in *four* minutes, its rotation is performed in one minute *more* than its revolution. Then, if it revolves in *five* minutes, it would seem necessary to conclude that its rotation is performed in *exactly the same time* as its revolution. But here we are suddenly stopped in our conclusions by Mr. Perigal, who says, "You are quite deceived: in this last case, *it does not rotate at all—it merely revolves.*" So, then, if the angular velocity of rotation is in the slightest degree *more* or *less* than the angular velocity of revolution, it is allowed that the body does rotate; but when it is *exactly the same*, its rotation ceases! And this, though, to an eye in the direction of its axis, its various points continue to describe circles, and in the same time as before!

Once more:—the *necessity* of rotation in such a case may be stated thus.—Let a spherical body constantly present the same diameter to the point in space toward which it is moving. If that point is *fixed*, the body does not rotate; but if that point is varying in azimuth, as seen from the moving body, this body *must rotate* in order to keep the same diameter directed towards it. Now, if the movement is in a circular orbit, its azimuthal direction is constantly varying, and in order to keep the same diameter towards it a regular rotation is necessary, and at the same rate, or angular velocity, as that with which

the revolution is performed. And thus, as long as the rate of orbital revolution is uniform, the diameter at right angles to a tangent to the orbit will always point to the centre of revolution: but if the angular velocity of revolution becomes either greater or less than that of rotation, the said diameter will be directed either in advance of or behind the centre of revolution. And such is obviously the cause of the moon's *libration in longitude*.

The theory of the moon's rotation has been very unfairly stigmatized as an "unfounded assertion," or "dogma," or "assumption;" and those who maintain it have been styled "*assumptionists*." But such language is calculated, if not intended, to convey a very incorrect view of the origin and foundation of that theory; which is, in fact, a regular and legitimate deduction of a *cause* from the *observed lunar phenomena*: and that cause so arrived at is sufficient to explain and account for the appearances, which are otherwise unaccountable. The moon's *libration*, for instance, is precisely what must necessarily result from a uniform angular velocity of rotation combined with a variable velocity of revolution in an elliptic orbit; and it confessedly cannot be accounted for on the theory of non-rotation, notwithstanding its strange fallacies. We are therefore fully justified in adopting the theory which satisfactorily accounts for this very remarkable phenomenon, and in rejecting that which does not; while we are at the same time fully satisfied that it is the only theory which really accounts for and explains the fact of our seeing only one side of the moon's surface.

I remain, Sir, yours very respectfully,

Hopefield Observatory, W. R. DAWES.
Haddenham, Bucks: Oct. 1864.

THE SUN'S DIAMETER.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—I have only just seen the remarks of Mr. Hopkins in the late numbers of the *Register* on the variability of the sun's diameter; and although the discussion is well fitted to go hand-in-hand with that of the moon's rotation, I cannot refrain from sending a few remarks on the subject.

It was my constant habit, during four years (1861—64) spent between the Equator and 35° S., to observe the sun's diameter four or five times on and off the arc, as soon as possible after every lunar or other observation requiring the index error to be accurately known, and I *invariably* found the semi-diameter obtained by dividing the sum of the means on and off by four to agree, within the errors of observation (3″ or 4″), with that given in the *Nautical Almanac*, provided the instrument (a very good sextant) was tolerably well adjusted.

These observations were made at all periods of the year and at various altitudes (but never very near the zenith or horizon); and had the semi-diameter ever differed more than a few seconds from that in the *Nautical Almanac*, I should have made a note of it as something very strange and unaccountable.

I am, Sir, yours very obediently,

October 14, 1864. R. M. A.

[*The Sun's Diameter.*—We have received several other communications on this subject, some of which are of considerable length, but as Mr Hopkins' statements are disputed both by observers in England with the equatorial and at the Equator with the sextant, we think it for many reasons advisable to hold them over for the present. The following table gives the *Vertical Semi-diameter*, and the *Time* (or duration) *of passage of the Horizontal Semi-diameter*, of the Sun, for 1864, from the Nautical Almanac, and there is no doubt that actual measurements, taken on these days, at Greenwich, will be found to correspond with the computations. All that is required therefore to prove or disprove Mr Hopkins's statements is that the corresponding columns for the Southern Observatory should be filled up, and until that is done we do not feel justified in occupying our pages with discussions and theories founded upon observations not yet sufficiently confirmed.—*Ed.*]

ALTITUDE AND SEMI-DIAMETER OF THE SUN:

	AT GREENWICH.			AT THE CAPE OF GOOD HOPE.		
Date.	Alt.	Passage of S. D.	Semi-diameter.	Alt.	Passage of S. D.	Semi diameter.
1864	°	m. s.	′ ″	°	m. s.	′ ″
Jan. 1	16	1 11·09	16 18·2	79		
Feb. 1	22	1 8·31	16 15·9	73		
Mar. 1	32	1 5·38	16 10·0	63		
„ 25	41	1 4·45	16 3·7	54		
April 1	44	1 4·50	16 1·7	51		
May 1	54	1 6·08	15 53·8	41		
June 1	61	1 8·42	15 48·0	34		
„ 20	62	1 8·97	15 46·3	33		
July 1	62	1 8·75	15 45·9	33		
Aug. 1	57	1 6·59	15 47·9	38		
Sept. 1	47	1 4·38	15 53·7	48		
„ 15	42	1 4·05	15 57·2	53		
Oct. 1	36	1 4·37	16 1·5	59		
Nov. 1	24	1 7·00	16 9·8	71		
Dec. 1	17	1 10·34	16 15·9	78		
„ 22	16	1 11·29	16 18·0	79		
„ 31	16	1 11·10	16 18·2	79		

Since the above was in type, we have received the following communication from Mr Knott:—

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—We are taught in the ordinary text-books of Astronomy that the earth's orbit is an ellipse, having the sun in one of the foci, and that consequently the sun is nearer to us at one period of the year than he is at another. One of the evidences for this form of the orbit is found in certain periodic changes in the sun's apparent angular diameter, which has been shown by measurement to vary between 31′ 30″ and 32′ 36″ approximately, attaining its *maximum* early in January, and its minimum early in July.

That astronomers of all nations should agree in assigning an erro-

neous form to the earth's orbit, would seem, *à priori*, to be highly improbable; yet we are assured by your correspondent, Mr Hopkins, in the July number of the Register, that "the ellipticity of the earth's orbit is founded on an optical illusion," and in proof he adduces a series of sextant measures to show that in the Southern Hemisphere the sun's angular diameter is *least* at the very time when it appears *greatest* in the Northern Hemisphere, and vice versa. Mr Hopkins concludes the former of his two letters with the words "Hence it follows that the variable diameter of the sun is caused by our atmosphere, and is not the effect of variable distances. This fact may be confirmed at our observatories at the Cape of Good Hope and in Australia." Here, then, is a court of appeal of Mr Hopkins' own choosing; let us see what judgment Sir Thomas Maclear has to deliver in the cause.

On enquiry a few days ago, I found that there was no *recent* volume of Cape Observations in the library of the Royal Astronomical Society; but as the mere date of the observations was of no importance in the investigation before us, I selected Vol. I. of the series, containing the observations made at the Royal Observatory at the Cape of Good Hope in the year 1834. This volume contains 138 observations of the "Sidereal Time occupied by the Passage of the Sun's Diameter across the Meridian," made with a 10 ft. transit instrument of 4·9 inches aperture. From these observations I selected eleven, taking, for convenience,* the last observation recorded in each month, and reduced them to minutes and seconds of arc in the usual way, though with no pretensions to extreme accuracy. The resulting values I have arranged in a tabular form, and for comparison have inserted in a separate column the calculated values given in the Nautical Almanac for the year 1834. The table hardly requires explanation, but I may just remark that column 1 contains the dates of observation; column 2, the values of the sun's angular diameter, as deduced from the Cape observations; column 3, the corresponding values, taken from the Nautical Almanac; and column 4, the differences between the calculated and observed values.

Date of Observation.	Sun's Diameter as observed at the Cape.	Sun's Diameter from Nautical Almanac.	Difference, Calc: — Obs:
1834	′ ″	′ ″	″
January 31	32 29·3	32 30·0	+ 0·7
February 28	32 18·5	32 18·8	+ 0·3
March 30	32 6·7	32 2·8	— 3·9
April 29	31 51·0	31 47·0	— 4·0
May 30	31 32·4	31 35·0	+ 2·6
June 27	31 31·3	31 30·2	— 1·1
July 31	31 38·1	31 33·8	— 4·3
August 25	31 42·1	31 42·4	+ 0·3
September 30	31 59·5	32 0·4	+ 0·9
October 8	32 5·1	32 5·0	— 0·1
December 23	32 34·1	32 34·2	+ 0·1

* I adopted this plan for the sake of uniformity, as there were no observations in January or December early in the month. In November the sun does not appear to have been observed at all.

A glance at the numbers in the table will show how utterly erroneous (I use the word in no invidious sense) are Mr Hopkins' sextant measures, and, consequently, the conclusions he draws from them: they prove incontestibly that in the Southern, as in the Northern Hemisphere, the sun's apparent angular diameter is *least* in June or July, and *greatest* in December or January, a result at which, in company probably with many others, I cannot say that I am at all surprised. It only remains that Mr Hopkins should furnish a few explanatory details in reference to the measures he has brought forward, as it is pretty clear that there is some peculiarity either in the observer or in his instrument, either in the method of observing, or in the method of reducing his observations. I am, Sir,

Woodcroft Observatory, Cuckfield: Yours faithfully,
October 19, 1864. GEORGE KNOTT.

In a note to the Editor, dated Royal Observatory, Cape of Good Hope, 1864, Sept. 20, Sir Thomas Maclear remarks—"In the matter of the sun's diameter, to test—if worth while—the statements, your method * should be doubled—viz., both solstices at each station."

TABLE OF NEBULÆ.

Right Ascension, Twenty-three Hours.

NAME OF NEBULA	Right Ascension.	Declination.
430 Hersc. II Piscium......	23 7 50	+ 3 48
Of the last degree of faintness—practically invisible.		
18 Hersc. I Andromedæ ...	23 19 35	+ 41 48½
A small but very fine and bright planetary nebula.		

We have this month departed from our plan of describing only the nebulæ which are contained in "Smyth's Celestial Cycle," and have inserted that very curious and beautiful planetary nebula, 18 Hersc. I. Andromedæ. This, though small, is exceedingly bright, and bears almost any amount of amplification without destroying its apparent disc. We cannot conceive why so striking an object should have been omitted from the "Bedford Catalogue." With reference to our first nebula, we may say that it is quite invisible in any instrument of less than four inches of aperture, and is only seen in one of that size on a very dark night, by the most earnest and sustained attention, as the very ghost of a faint haze on the background of the heavens.

* That of comparing together the observations at Greenwich and the Cape for the same day.

ASTRONOMICAL REGISTER.

LIST OF SUBSCRIBERS—Names received since our last number.

Milner, Rev. J., Chaplain, H.M.S. Hector, Portland, Dorset.
Shawcross, W. Esq. Norris Bank Terrace, Heaton Norris, near Stockport.
Tupman, Lieut. G. L., F.R.A.S., Fishbourne, Chichester.

ASTRONOMICAL OCCURRENCES FOR NOVEMBER, 1864.

DATE.		h. m.	Principal Occurrences.	Jupiter's Satellites.	Meridian Passage.
Tues	1	 1 33 11 26	Sidereal Time at Mean Noon, 14 44 6·0 Conjunction, Moon and Jupiter, 1° 27′ S. Conjunction of Moon and Venus, 3° 25′ S.	The Satellites are invisible this month, Jupiter being too near the Sun.	h. m. Neptune. — 9 39·1
Wed	2		Declination of Neptune, +1° 0′		9 35·1
Thur	3				9 31·1
Frid	4				Moon. — 3 56·6
Sat	5				4 50·8
Sun	6	11 53	Moon's First Quarter		5 44·2
Mon	7				6 36·9
Tues	8				7 29·1
Wed	9	19 5	Superior Conjunction of Mercury		8 21·3
Thur	10	11 52 12 6 13 10	Near approach of Moon to 60 Piscium (6) Occultation of 62 Piscium Reappearance of do. (6)		9 14·3
Frid	11				10 8·5
Sat	12	16 29	Near approach of Moon to σ Arietis (6)		11 4·0
Sun	13	5 33	Full Moon		12 0·4
Mon	14	15 6 17 20 18 2 21 23	Near approach of Moon to B.A.C. 1468 (6) Occultation of ι Tauri (5½) Reappearance of do. Conjunction, Moon and Mars, 4° 12′ N.		Neptune. — 8 47·0
Tues	15	22 39	Conjunction of Moon and Uranus, 4° 12′ N.		8 43·0

DATE.		h. m.	Principal Occurrences.	Jupiter's Satellites.	h. m. s.	Meridian Passage. h. m. Neptune.
Wed	16	 16 34	Sidereal Time at Mean Noon, 15 43 14·3 Near approach of Moon to 26 Geminorum ($5\frac{1}{2}$)			8 39·0
Thur	17	15 12	Near approach of Moon to 68 Geminorum ($5\frac{1}{2}$)			8 35·0
Fri.	18					8 31·0
Sat	19	11 27 12 16	Occultation of κ Cancri (5) Reappearance of ditto			8 27·0
Sun	20	19 17	Moon's Last Quarter			8 23·1
Mon	21	14 51 16 5 16 49	Occultation of 36 Sextantis Reappearance of do. (6) Conjunction of Jupiter and Mercury, 1° 54′ S.			8 19·1
Tues	22					8 15·1
Wed	23					8 11·1
Thur	24		Declination of Neptune, +0° $51\frac{1}{2}'$			8 7·2
Fri.	25	15 46	Conjunction of Moon and Saturn, 3° 38′ N.			8 3·2
Sat.	26					7 59·2
Sun	27					7 55·2
Mon	28	19 17 20 11	New Moon Conjunction of Moon and Jupiter, 1° 58′ S.			7 51·3
Tues	29	15 51 19 26	Conjunction of Moon and Mercury, 6° 17′ S. Conjunction of Jupiter with the Sun.			7 47·3
Wed	30	17 58	Opposition of Mars.			7 43·3

THE PLANETS FOR NOVEMBER.

Mercury passes from Virgo to Ophiuchus during November, and arrives at superior conjunction on the 10th: it is therefore badly situated for observation, owing to its nearness to the Sun.

1st	R.A.	14 7 49	Dec.	S.	11 58	Diameter	4"·8
30th	"	17 14 40	"	S.	25 0	"	4"·8

Venus is now increasing in brightness, and will shortly be well situated for observation. It is in Scorpio at the beginning, and in Sagittarius at the end, of November.

1st	R.A.	16 20 14	Dec. S.	22 22	Diameter	11"·6
30th	"	18 56 2	"	24 42	"	12"·8

Illuminated portion of the disc of Venus=0·858.

Mars is now a most conspicuous object in the evenings, and is well situated for observation, although not so near to us as at the last opposition: it rises at six o'clock at the beginning, and at half past three at the end of the month. It continues in Taurus, being situated nearly in a line from Aldebaran to Beta Tauri, and is traveling towards the Pleiades, thus adding greatly to the magnificent appearance of this fine portion of the heavens.

1st	R.A.	5 8 39	Dec. N.	23 21	Diameter	15"·6
30th	"	4 30 46	"	23 44	"	16"·4

Illuminated portion of the disc of Mars=0·985.

Jupiter is in conjunction with the Sun at the end of the month, and consequently cannot well be observed; **Saturn** also, although visible in the east in the early morning, will scarcely yet repay the trouble of observation.

Uranus however may be well observed, rising a little before seven o'clock in the evening at the beginning, and a little before five at the end of the month. It continues in Gemini.

4th	R.A.	5 56 17	Dec. N.	23 38½	Diameter	4"·0
28th	"	5 52 51	"	23 38½	"	4"·2

Neptune also is well placed for observation: we give its time of transit, and also its declination, in the Table of Occurrences.

4th	R.A.	0 24 33	Dec. N.	0 59
28th	"	0 23 7	"	0 51

THE MINOR PLANETS.

The following are the Minor Planets which will be on, or within one hour of Right Ascension on either side of, the Meridian, between nine and twelve oclock during the evenings of November. Their places are to be found in the *Supplement* to the *Nautical Almanac* for 1867.

	Magnitude.		Magnitude.
Ceres	8·0	Harmonia ...	8·8
Metis	8·6	Echo	11·6
Amphitrite ...	8·7	Maximiliana ...	11·8
Polyhymnia ...	11·1	Hesperia... ...	11·8
Fides	9·6	Clytie	—

INSTRUMENTS, &c., FOR SALE.

These Notices, which are restricted to *three lines* each, are inserted free of charge to subscribers: applications respecting prices and other particulars to be made to the Editor, with a stamped envelope for reply, without which *no answer can be sent.*—For Advertisements with prices and more complete details, a small charge will be made.

Equatoreal Telescope, 5½ ft. focus, 4¼ in. aperture, powers 60, 340, and 450, on extra stout mahogany tripod stand, steadying rods, levels, large finder, &c., complete. [18]

Astronomical Refractor, focal length 4 feet, aperture 3⅜ inches, complete, on a Portable Universal Equatoreal Stand. [8]

Achromatic Refractor, 44 in. focus, 3½ in. aperture, on a Fraunhofer's Universal Equatoreal Stand. [7]

Achromatic Refractor, 4 ft. 6 in. focal length, 3½ in. aperture, by *T. Cooke & Sons*, Equatorially mounted, on tripod stand. [36]

Achromatic Refractor, 4 ft. focal length, 3 in. aperture, on brass tripod stand, with achromatic finder, 3 celestial and 3 terrestrial eye-pieces, &c. [20]

Newtonian Reflector, 7 ft. focus, 7¼ in. aperture, eight eye-pieces, powers from 30 to 360, Equatoreally mounted. [11]

Transit Instrument, 5 ft. focus, 3¾ in. aperture, Ys fitted with agates, for mounting on stone piers. [29]

Equatoreal Mounting, (for Latitude 51 or 52), adapted for a telescope of 6 or 7 foot focus.—12 inch Circles, Driving apparatus, &c., all of the most approved construction. [5]

Improved **Varley Stand,** with rackwork movements, adapted for a telescope of 5 or 6 ft. focus: fixed upon a circular turn-table, so as to be easily pointed in any direction. [16]

Recreative Science: complete in numbers, half-price. [30]

TELESCOPE FOR SALE.—One of Messrs. SOLOMON'S £5 ASTRONOMICAL REFRACTING TELESCOPES to be SOLD, nearly new.—Focal length, 44 inches; clear aperture, 2¾. Price Four Guineas, with terrestrial eye-piece, table tripod stand, and box, complete. [31] H

FOR SALE—an excellent REFLECTING TELESCOPE, focal length 7 feet, aperture 7¼ inches, mounted so far Equatoreally that with a little care it may be turned on a star or planet in the day time.—Four Eye-pieces.—Price £20 only, (less than the cost of the stand,) the proprietor having mounted a larger instrument. [11] F

ACHROMATIC TELESCOPE FOR SALE, 10 ft. focal length, 6 in. clear aperture, by *Goddard*, with finder of 2 in. aperture, six eye-pieces, powers from 20 to 1000, mounted on a mahogany stand upon a new and improved principle.—Apply to Mr S. Corke, Auctioneer, &c., Sevenoaks, Kent.

INSTRUMENTS, &c., WANTED.

Achromatic Object Glass, Wanted, from 4 to 5 inches clear aperture, ready fitted in cell, second hand, cheap. [37]

Equatorial Stand, Wanted—adapted for a 5 ft. Refractor, with graduated circles; second hand, at a moderate price. [35]

Monthly Notices of the Royal Astronomical Society.—The third Volume wanted: a good price will be given. [26]

"WORK! WORK!"—"I have witnessed," says Admiral Smyth, in the *Speculum Hartwellianum*, "with very deep regret, the *vis inertiæ* perceptible in certain quarters of the amateur world, wherein zeal so frequently evaporates in the note of preparation. While certain staid Philasters voluntarily engage themselves in systematic labour for the benefit of science, it is notorious that there are several private, well built and well equipped Observatories among us, wherein no useful observations, or matters worthy of record, are made or undertaken to be made, save when a publicly notified phenomenon is to be seen. To be sure, a well mounted telescope ought to be an appropriate and desired article for every educated gentleman's establishment, both for amusement and expansion of mind; and the Earth noiselessly rolling on its axis presents a new field for admiration with every passing hour. What scenes in the diurnal revolution of the celestial sphere, in the 86,400 seconds from the time of a star's passing the middle wire to its return to the same point! The whole is a marvellous moving panorama, one day pressing on the heels of another, and the Moon under continual change:—

Truditur dies die,
Novæque pergunt interire Lunæ.

But this, so much better than neglect, has no more to do with the desiderata of Astronomy, than swimming has with the composition of water. Instead, therefore, of bruiting and advertising their instrument rooms as Observatories, it were better they should recur to the more honest and correct term, *gazebo.* Not but there are those lovers of Urania, a zealous band, who have resolutely climbed the cliffs of knowledge to enter the Temple of Science by its only true approach; and have rendered such valuable and essential service to the cause, that they ought never to be confounded with the gazers alluded to. By the accurate advances of this force, observations are furnished for the discussion of the geometer and the generalization of the philosopher; and it is a course which may elevate the amateur to the platform of science, without lowering science to the level of the amateur."

ASTRONOMICAL REGISTER—Subscriptions received by the Editor for 1864.

To June.	To September.	To December.
Frodsham, C. M.	Lancaster, W.	Ingall, H.
	Webb, Rev. T. W.	Leigh, Jas.
		Shawcross, W.
		Tupman, G. L.

NOTICES TO CORRESPONDENTS.

Whirligig.—Our Correspondent has not favoured us with his name.

Communications received from *F. Bird—H.—Evan Hopkins—Query*—and *Nauticus.*

The Moon Controversy.—We have a few more letters on this subject, which will appear in our next if possible; after which we cannot give more than a portion of a page each month to this discussion, should any of our correspondents have *fresh facts* to bring forward.

Reprints, or Extra Copies.—*Correspondents who require separate copies of their communications can have them at a charge of* 6s. 6d. *for* 50 *copies, if not exceeding four pages, or* 10s. *up to eight pages; or they can be supplied with extra copies of the Register at a reduction of* 25 *per cent, when more than three copies are required.—Notice must be given to the Editor before the end of the month, when reprints are required.*

The Astronomical Register *is intended to appear at the commencement of each month: the Subscription (including Postage) is fixed at* **Three Shillings** *per Quarter, payable in advance, by postage stamps or otherwise.*

The pages of the ASTRONOMICAL REGISTER *are open to all suitable communications: Letters, Articles for insertion, &c., may be sent to the Editor,* MR S. GORTON, Stamford Villa, Downs Road, Clapton, N.E., **not later than the 20th of the month.**

The Astronomical Register.

No. 24. DECEMBER. 1864.

THE PHYSICAL AND CHEMICAL CONSTITUTION OF THE NEBULÆ.

By the publication in the *Philosophical Transactions* of a paper by Mr. Huggins, forwarded to the Royal Society on the 8th of September last, entitled "On the Spectra of some of the Nebulæ," being a supplement to the one by Dr. Miller and himself "On the Spectra of the Fixed Stars," we are enabled to resume the subject of spectrum analysis applied to the heavenly bodies, and give some account of the important discovery hinted at in our last number. The question of the existence or not of truly nebulous matter has long been a vexed one; but the gigantic telescopes of Lord Rosse had certainly caused a preponderance of evidence in favour of the stellar character of the nebulæ, tending to show they were but clusters irresolvable by reason of their distance only. Still there were difficulties in the way of this theory, arising from the occurrence in connection with resolved nebulæ of wisps and patches of nebulous light, and especially the appearance of the planetary nebulæ, whose uniform discs of light were totally irreconcilable with the form of a globular cluster of stars. Lord Rosse, it is true, had indicated that they might be annular, with a gauzy film occupying the centre; but this had not been proved with the majority of the bodies.

In the autumn of the present year, Mr. Huggins determined on trying the effect of his new method of research on these curious objects, and on August 29 turned his apparatus on one of the most beautiful, 37 H. IV. Draconis, a small bright bluish

disc of light. To his great astonishment, no coloured spectrum could be seen, but only a short line of light perpendicular to the usual direction of the length of the spectrum. Closer investigation showed another bright line at a considerable distance, and, further still, a third of extreme faintness. It was clear, therefore, that the light of this nebula was not of numerous degrees of refrangibility, but of one or two only. The discoveries of Kirchhoff also prove that it is only solid or liquid bodies in a state of incandescence which give continuous spectra, while luminous gases have spectra of bright lines. This nebula, therefore, consisted of a gas or several gases at an enormous temperature. A comparison of the bright lines with terrestrial elements showed that the brightest line was caused by nitrogen, the faintest by hydrogen, while the third nearly coincided with one of the barium lines.

This wonderful result was soon confirmed by other instances. The Nebula Σ 6 Taurus Poniatowski had the same three bright lines. 73 H. IV. Cygni presented the same appearance, with the addition of a faint continuous spectrum, which was conclusively proved to be due to an 11th magnitude star in the middle. 51 H. IV. Sagittarii, 1 H. IV. Aquarii and 18 H. IV. had the same spectral analysis, the last-named showing a fourth more refrangible faint line. The ring Nebula 57 M. Lyræ, and the Dumb Bell 27 M. Vulpeculæ, gave the nitrogen line only, save a suspicion of another in the first of the two objects, which, from its showing two lines of light, one above the other, corresponding to the sections of the ring, was an exceedingly curious study.

A number of objects, which are clearly clusters, were then tested, including 92 M. Herculis, 50 H. IV. Herculis, 55 Andromedæ, and 26 IV. Eridani. They all gave continuous spectra, proving their stellar nature.

The nebulæ examined differ, then, from our sun and the fixed stars, not in degree only, but in plan, being constituted entirely in a different manner. Instead of being solid or liquid bodies, emitting light of all refrangibilities, portions of which are intercepted by the vapours of their surrounding atmosphere, producing the dark lines of the solar and stellar spectra, these nebulæ consist, or at least their outer surfaces must, of enormous masses of luminous gas or vapour, as it is only from such bodies that light of certain definite degrees of refrangibility is known to be emitted.

It is needless to speak of the importance of this discovery, after the manner in which the President of the Astronomical Society alluded to it in his address at the last meeting. The space which the *Astronomical Register* can afford to any subject, however important, is necessarily very limited, and we would therefore, in conclusion, refer those of our readers desirous of further details to a paper written by Mr. Burr, with the concurrence and assistance of Mr. Huggins, which will appear in the next number of the *Intellectual Observer*, and which will contain a coloured plate of the stellar spectra, as well as engravings of the apparatus employed, and the appearance of the bright lines of the nebulous spectrum.

COMETOGRAPHY.—M. Galle announces that he hopes to have ready by May or June in next year his new Catalogue of Comets. This work, if well carried out, as we may be sure it will be, will be very valuable.

THE COMET OF AUGUST LAST.—A correspondent sends us the following:—Professor Coxwell contributes the following to the *Philadelphia Press* of the 24th Aug.:—"Last evening the tail of one of the most magnificent comets on record was seen in this city when not obscured by the mists and clouds in the west. At eleven o'clock the tail extended nearly to the constellation Draco, or more than 60° from the horizon. Supposing the nucleus to be at least 30° below the horizon at that time, the extent of the tail would have been 90°. Of the great historic comets, that of the year 371 B.C. had a tail of 60°, according to Aristotle. The comet of 1618 is recorded as having a tail 104° in length; that of 1860 had a tail of 70° to 90°; that of 1769, a tail of 97°; and that of 1843, a tail of 65°. These figures are taken from *Herschel's Outlines of Astronomy*. Should the present comet prove equal in brilliancy to its size, it will be the most remarkable one which has appeared to this generation."—*Birmingham Daily Gazette, Sept.* 15, 1864.

PRACTICAL ASTRONOMY.—Copies of a new treatise on *Spherical and Practical Astronomy*, by Professor Chauvenet, of Washington, St. Louis, have recently arrived in England. The work is in two massive octavo volumes, very clearly and finely printed: it embraces a very detailed account of the subjects on which it treats, including specially time and instruments, with elaborate formulæ of all kinds. Taken as a whole, probably the book will not be found so widely useful as Loomis's well-known *Practical Astronomy*, on account of its exhaustive character; neither are the tables by any means so numerous or well selected. It may be procured of Williams and Norgate, Henrietta Street, W.C., for £2 2*s*.

POLARIS.—An important memoir on the right ascension of this star has just been completed by Mr. T. H. Safford, of Harvard College Observatory.

ROYAL ASTRONOMICAL SOCIETY.

First Meeting, November 11, 1864.

Warren De la Rue, Esq., F.R.S., *President*, in the Chair.

Secretaries, Rev. C. Pritchard and Mr. Hodgson.

One hundred and twenty-four presents were announced, of which two were particularly referred to: first, a volume in Spanish containing an account of the Astronomy of the 13th and 14th centuries, by King Alphonso of Castille; secondly, two manuscript volumes, by Sir John Herschel, containing the numerical co-efficients of his equations for the determination of the curves for an aplanatic object-glass, which were to be deposited in the custody of the Society for the use of its members. These calculations were made twenty years ago, and Mr. Pritchard observed that anyone wishing to calculate the curves of an object-glass would here find about one-third of his work done for him.

Ed. Tyers, Esq., and
E. Beauman, Esq.,

were balloted for, and duly elected Fellows of the Society.

Dr. Donati,
Professor Luther, and
Dr. Rudolf Wolff,

were balloted for, and duly elected Associates.

The names of several gentlemen were ordered to be suspended for non-payment of their subscriptions, many of several years' standing.

The President stated that at the next meeting he should have to ask the Fellows of the Society for a vote of confidence in the Council: last year no medal was awarded; but it was proposed this year to give no less than three medals. It would of course be unadvisable at present to mention the names, but he had to give notice that the next meeting would be made special, in order to suspend the bye-laws, and authorise the Council to award two

or more medals; and he trusted their votes would enable them to do so.

Mr. G. F. Chambers begged to put a question as to the library, the state of which he considered by no means satisfactory. A large number of the publications were not bound, and some of them were scarcely in a readable state. Another thing was that many members kept the books for an unreasonably long time, which was not fair to others who wished to read them: if one or two months were too short a time, let a longer time be allowed; but do not let the existing laws on this point be broken.

Mr. Pritchard expressed his obligation to Mr. Chambers for bringing forward the subject. He did not think the library was in the best condition. However, they had been putting their finances in order, and they would then see to the library, after which they hoped to be able to make some better arrangements with regard to the instruments. But in the instance of gentlemen keeping the books too long, he thought that in any case of the kind the book had always been returned if a member expressed a wish to have it.

The President then gave a very interesting account of various matters connected with astronomical science which had transpired during the recess, commencing with his journey to attend the celebration of the 25th anniversary of the establishment of the Pulkova Observatory, at which he was present, and of which we gave a short notice in our number for October, page 252. He also referred to the completion of the Wilna photo-heliograph, which was constructed by Dallmeyer under his directions. M. Otto Struve having considered Mr. De la Rue's method worthy of adoption in Russia, he had undertaken the superintendence of the instrument in question, which contained several improvements. The President also noticed the German Astronomical Society, its objects being somewhat different from ours; it has no honorary members, &c., and is, in fact, a co-operative society of astronomers, to effect an interchange of ideas, and otherwise aid astronomical science. One of its objects was to prevent two or more astronomers working upon the same subject, so as, if possible, to economise the zeal of observers by concerted action. Another point to which its efforts would be directed was the reduction of old observations, so as to make them useful in confirming modern

theories. "The question now arises," said Mr. De la Rue, "how can our Society ally itself with this younger Association? At any rate, we can individually, like Adams and myself, join the Society, and so become entitled to its publications." Mr. De la Rue then gave the names of the principal officers of the Russian Observatory, with some account of its construction and of the condition of the instruments; he went into some detail as to the method there employed of recording transits by galvanism; and concluded the portion of his experiences of continental astronomy by stating that the subject of parallax of the fixed stars would be pursued in a small observatory at some distance from the large one at Pulkova, with a telescope of 5 inches in aperture, by Steinheil, of short focus, which had been ordered for the purpose. Returning to what had been the progress of astronomical science in England, the President stated that the Liverpool Observatory was about to be removed to Birkenhead, which change would, in Mr. Hartnup's opinion, be very beneficial. The progress made in many places in controlling clocks by electricity also called for notice, and it was a thing to be regretted that up to the present time London was without any such means of ascertaining correct time. Since July, two important papers had been published by the Royal Society; the first, a list of 5,079 star clusters and nebulæ, by Sir John Herschel, the appearance of which is most opportune, as Mr. Lassel's great reflecting telescope is about to be transferred from Malta to Melbourne, and used in the observation of this particular class of objects. It might be stated that Mr. Lassel, with the aid of Mr. Marth, had added about 500 nebulæ to those already known; but it was found that the numbers of nebulæ did not increase as might be expected from the employment of these large instruments; in fact, increase of aperture adds to the brilliancy of the neighbouring stars, and so renders the nebulæ less visible. The other paper had reference to the important question of the constitution of the nebulæ. Lord Rosse, with his gigantic telescope, had turned many into clusters, but aperture alone seemed unable to settle the question. The application of spectrum analysis by Kirchhoff proved that gases and vapours, though seemingly transparent, might be quite opaque to the sun's rays, thus forming the dark lines of the solar spectrum, while the bodies so intercepting the light would themselves when incandescent give bright lines

in the same places. By this discovery four new elements had been added to our lists, and the spectra of the stars had been examined by Fraunhofer, Donati, Rutherfurd, Secchi, Airy, Winnecke, and Dr. Miller and Mr. Huggins. The last-named gentleman, one of our members, was the author of the second paper mentioned, being a supplement to the one by Dr. Miller and himself. It was a contribution of the highest value, and, using spectrum analysis as the means of research, Mr. Huggins had proved that the planetary nebulæ give lines such as would be produced by heated gases only, and were therefore not clusters of stars. Dr. Donati has found the same kind of lines in the spectrum of comets, which may therefore also be of the nature of gas, and perhaps self-luminous.

The President's long and interesting communication was received with great applause, and the Astronomer-Royal rose to propose that the thanks of the meeting be given to Mr. De la Rue, which was carried unanimously.

On the Forms proposed by Sir J. Herschel and Gauss for an Aplanatic Object Glass, by Mr. Pritchard.—The author gave a verbal account of this paper, stating that it arose from the discussion originated by Mr. Hodgson at the last meeting, when he gave the formulæ for the 4 radii of an aplanatic object-glass. Since that time Mr. Pritchard had received two letters, one from Sir J. Herschel accompanying the calculations referred to in the list of presents, and one from Mr. Newman to Sir J. Herschel dated in 1845, Mr. Newman having calculated the tables of coefficients for Sir John. Mr. Newman points out two important matters to be attended to. The one is to determine the indices of refraction of the specimens of glass used with the greatest nicety, even to three places of decimals, as without this the tables are useless. The other point is as to the thickness of the lenses, but this Mr. Pritchard did not think so important. Sir J. Herschel in his letter refers to the form suggested by Gauss and adopted by Steinheil, and Mr. Bond also speaks of it as exciting great interest.

It is well known that every kind of lens has a form in which the spherical aberration is at a minimum. In a double convex of glass having 1·5 for its index of refraction, the ratio of the curves for this form is as 1 to 6; on either side of this form there may be curves of any radii giving different amounts of

aberration; but whatever form may be selected on one side, there will be a corresponding one on the other with the sides reversed which will have precisely the same amount of aberration. Thus, suppose, as in the Herschelian object-glass, there is a crown glass convex lens A, having the flat side to the luminous object, corrected by a flint glass concave B; then there will also be a form C exactly corresponding in aberration, which will have the most convex side towards the object, and be corrected by a flint concave lens D, having the concavity on the opposite direction to that of B. Now the form composed of A and B is the Herschelian form, which was also Fraunhofer's plan, and the latter C and D is that proposed by Gauss and executed by Steinheil. It is clear, therefore, that they must be equal in their power of doing any work, but it may happen that there is some reason why one may be more desirable than the other; and therefore when it is found that in Herschel's form the lenses can be and are nearly or quite in contact, while in Gauss's they cannot be, and that the former can be readily ground, while the latter are constructed with great difficulty, it is sufficiently apparent that Herschel's plan is most useful, and that the other, with far greater labour, only attains the same result.

Mr. Pritchard also said that another paper on the subject had been sent by Mr. Simms, who stated that the form attributed to John Dollond, but which was really a Dutch idea, and was still used by Mr. Cooke, having the front side of the crown glass lens most convex, and a double concave flint correcting lens, would give a tail or coma to every star viewed. It was, however, very much used, as being easier to make than the Herschelian form.

Mr. Hodgson was much obliged to Mr. Pritchard for the trouble he had taken; but he thought the difficulty was not in getting curves calculated, but in making the tools to grind the glasses. It seemed as if opticians must be continually changing their tools, which it was not likely they would do. The form used by Dollond and Cooke was a good one, as the lenses were close, and the image consequently sharper. He considered Steinheil's object-glass a sort of "lusus naturæ."

Mr. Slater said that as to the coma referred to by Mr. Simms, he believed it was due, not to the object-glass, but solely to the eye-piece.

Mr. Dallmeyer: I should like to ask one or two questions. Does the Gauss form correct the neighbouring parts of the spectrum, say to the line D, better than the Herschelian? Because, if so, then it would admit of a larger aperture for the same focal length.

Mr. Pritchard: I will give a definite reply. I am not aware that the one form possesses any property whatever that the other does not; they are cognate in their action, and do the same thing. Opticians now make the aperture 1-15th of the focal length; he was convinced that with a little more trouble they could make it 1-12th. If English opticians would but take one-twentieth part of the trouble the Germans do, they would produce much better object-glasses.

Mr. Airy: I think Mr. Dallmeyer meant, can you correct the irrationality of the spectrum?

Mr. Dallmeyer: Yes.

Mr. Airy: Then I may say that with lenses in contact this cannot be done, but with them apart it can be very much reduced.

Mr. Dallmeyer: The Dollond form of object-glass, as I stated at the last meeting, gives a coma, and the coma is greater if the glass is bent. Now to try if Herschel's does so, it is only necessary to bend the curves, as it were, the opposite way, and if the coma goes to the other side it is due to the object-glass. I believe such coma when existing can be corrected by the eye-piece.

Mr. Pritchard said he should investigate the subject further, but he must again impress upon opticians the importance of measuring the index of refraction, by which they would save themselves much trouble.

Mr. Slater said, opticians did measure it; not perhaps by using the glass as a prism, but by making a lens, and from its focal length getting the refractive index.

Mr. Pritchard: This way won't do as well.

The President: It is one thing to calculate, but another thing to produce correct curves; each approach to perfection in an object-glass is obtained by smaller and smaller increments. I have in my possession a telescope of a little over four inches aperture, which I have never seen equalled; and I believe this to be entirely owing to the great amount of labour expended upon it.

Mechanical skill and theory must be combined in producing a perfect object-glass. In the glass by Steinheil, which passed through my hands, the lenses were widely separated.

Papers by Mr. Alex. Herschel *On the Radiant Point of Shooting Stars*—Mr. Brodie *On a Meteoric Appearance on the Sun's Surface*—*Description of an Observatory at Quebec*, by Mr. Ashe—Mr. Tebbutt *On the Discovery of Comet I*, 1864, *in Australia*—Professor Challis *On the Bright Band on the Moon's Limb in Solar Eclipses*—and Mr. Perry *On the Variation of the Moon's Place produced by the Motion of the Ecliptic*—had the titles announced, and were taken as read.

A meridian circle, formerly belonging to Sir Thomas Brisbane, was presented to the Society by Mr. Fletcher.

CORRESPONDENCE.

N.B.—We do not hold ourselves answerable for any opinions expressed by our Correspondents.

THE NOVEMBER METEORS.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—The following extract from a letter received this morning from a correspondent on the passage to Malta from Marseilles, describing the meteoric phenomenon of the 13th inst., is quite at your service, for those of your readers whom the subject may interest. Although it offers no consolation to those who, like myself, were disappointed by the cloudy state of the sky in their attempts to watch the display on the nights of the 11th to the 14th inst., it is nevertheless an earnest of what may be expected of this phenomenon in the year 1866, when (it is well known) its intensity will culminate. The absence of meteors on the morning of the 14th November, observed here as well as at Malta, is a sign of the narrow and well-defined limits of the group of bodies through which the earth passes at the date in question. Should the passage of the earth through the centre of this group in 1866 unfortunately happen in the day-time, no great meteoric display can be expected in the night. The moon will, on

the other hand, be favourable in the years 1866 and 1865, being then in its first and last quarters.

I am, Sir, your obedient servant,
ALEXANDER S. HERSCHEL.

Collingwood, Hawkhurst:
Nov. 21, 1864.

Extract.—" S.S. Ellora, off Malta, Nov. 14, 1864.—There has been some sad mistake about the meteors. We got out the maps last night (Sunday evening) and studied the skies, and made all our arrangements, but not a single meteor could be seen. I watched till 11½ h. myself, and told the watch to wake me up if any more were seen; and, in any case, at five o'clock. He did so, but reported that not one had been visible. I looked out for a little while. The sky was quite clear, but bright moonlight, and not one single 'piff.' The watch told me in the morning that there had not been a single one visible till daylight! It turned out that there had been a grand display between 12 and 4 all through the watch the *night before*—Saturday to Sunday. The watch, an old salt and intelligent man, said it was the grandest shower he had ever seen, and said that all the watch had been looking at them with delight. There were no striking ones, and none burst. I could make nothing more out of him than this."

THE PLANET MARS.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—I have to thank your correspondents, the Rev. T. W. Webb and G. W., for the elements of Mars, with which they have kindly furnished me, although my query referred to the direction of the axis only.

This element will be useful to those of your readers whose attention has not been directed to Mars further than as an interesting object of telescopic observation; for although the changes in the features of the planet are mainly due to rotation, the position of the axis with reference to the earth not only brings the northern and southern polar regions alternately into view, but likewise affects the apparent direction in which the "markings" traverse its surface.

A diagram on a large scale, constructed as briefly described below, shows these changes very clearly, and is also serviceable for reference, especially in comparing drawings made now with those of 1862. Both these objects are better attained by substituting for the small circle representing Mars in the diagram one of the smallest—sized mounted globes of the earth, which not only in addition shows the inclination of the axis to the ecliptic (the earth's of course, but that of Mars is not very different), but if the results obtained from drawings at the last opposition be depicted upon it as I have seen done by Mr. Green, will besides, when viewed from a point representing the earth's longitude at the time, and turned slowly round,

help to determine the identity of the present markings with those then seen.

Your more learned readers will, I am sure, excuse the commonplace remarks and suggestions I have offered; but, trusting they may not be altogether useless,

I am, Sir, your obedient servant,

Ealing: Nov. 18, 1864. W. L. BANKS.

The Diagram.—Draw two arcs of circles of about 100° for the part of the orbits of the Earth and Mars in which they now are, and, marking the right end of the arcs as longitude 348°, set off with any convenient divisions the longitude to the other end, which will be about + 88 (the opposition is at 69°).

For the day required, take the heliocentric longitude of the Earth and Mars from the Nautical Almanac, and describe small circles on the arcs at the places found. Let these be marked E and M respectively, and they will represent the Earth and Mars as situated to each other; and a line drawn through M "parallel" to one joining 348°, with the centre of the arc, will be the direction of the axis, and may be marked N S.

Then draw a line from the centre of the circle E to that of M, and through M draw a diameter at right angles to the line E M. The angle between this diameter and the axial line N S will show the situation of the poles of Mars from the edge of his disc, as seen from the Earth. If this be done for the middle of September, it will be seen that the South Pole was then within the visible hemisphere. Early in October both poles were on the edge of the disc, since which the South Pole disappeared, and comes again more and more into view at and after the opposition.

MERIDIONAL v. *MERIDIANAL.*

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—It would be vain to undertake to reform the manifold anomalies and caprices of English orthography by rigorous classical derivation. When usage plainly sanctions, as is sometimes the case, even a glaring error in spelling or pronunciation, it is better to go wrong with the many than affect a pedantic precision. I must confess, then, that Admiral Smyth's broadside has brought my craft into a sinking state, and in future I must conform to the practice of the illustrious fraternity he cites, from Jonas Moore to the present time; and I am really as glad to find one who never writes without amusing as well as instructing, in the right, as I should have been if I had happened to have myself the best of the argument. At the same time, elegant and profound scholars are not infallible, and we should never blindly defer to mere names, however deservedly weighty. Whilst upon these minutiæ, it may be noticed that the same argument which tells in the case of "meridional" in favour of the Admiral would bear against Sir John Herschel in the words "appre-

ciate," "appreciable," which seem also to have come from the French, but which Sir J. H., if I remember right, always spells "appretiate," "appretiable,"—and of course correctly, if we derive them directly from the Latin.

Yours faithfully,
G. J. W.

November 1864.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—As some of your readers have been kind enough to set the others right in the spelling of such words as "meridional" and "equatorial," perhaps the same authorities would tell us whether we may properly use such a word as *adjustible*, or *adjustable*, and which is the correct way of spelling it? There is no such word in the dictionary; but when we speak of the declination or hour circles requiring to be rectified, we want the term. We have no Latin adjective here to guide us, and I am disposed to spell it *adjustible*; because the only word like it which I know is *combustible*: otherwise I should spell it with an "a," which is the more common penultimate of many of our adjectives.

ANOTHER ENQUIRER.

Nov. 10, 1864.

THE SUN—A DARK BODY OR LIGHT?

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Mr. Editor,—Upon looking over some elementary astronomical works lately, I was struck with the remark (which I have, like all other astronomical readers, been familiar with time out of mind), namely, that the spots on the sun are portions of the body of the sun itself appearing through openings occasionally made from certain causes in the "luminous envelope" which surrounds it.

Now, admitting that the source of light is to be found in this envelope, I don't quite comprehend how the rays of light are only dispersed *externally* throughout the great region of what we term our "Solar System," and not either thrown on the sun's surface by reflection or refraction, &c. &c. There are endless things in the wonderful and stupendous created system in which we are placed far beyond our comprehension, I most cheerfully admit, and this is one of them.

Perhaps some of your intelligent correspondents can enlighten me upon this point.

Yours truly,
READINGENSIS.

Nov. 18, 1864.

THE MOON'S ATMOSPHERE.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—In my work on *Geology and Magnetism*, printed in 1843, I made the following remarks:—"There is another idea propagated respecting the moon that requires further consideration: viz. that she has no atmosphere, because we do not observe any refraction during the occultations of the stars. If the moon be enveloped in an atmosphere like ours, the angle of refraction would necessarily be *between the moon and the star*, the ray from which would, on infringing on the surface of the moon, be again reflected towards the earth. If a ray of light be successively transmitted through several transparent media, having different curves and refracting properties on one side, and be again reflected so as to pass through similar media on the other side, its emergence from the last of these angular or concentric media will take a direction similar to that which it had when incident upon the first of them. In this case, the bends by refractions which the ray suffers in passing through the media on one side, are compensated and neutralised in its emergence from the opposite media, and thus produce on the whole no apparent deflection of the ray from its original course. The angle of incidence is equal to the angle of reflection. The reason why we observe refraction of the rays on earth is, because we are *within* our atmospheric sphere. Had we been placed *outside* our atmosphere, we should not have been able to see the sun in our horizon as we do now when it is below it and opposite the centre of the earth, as the angle of refraction would be neutralised by the other half of the spherical media. Yet we are told that, because the moon does not show signs of refraction similar to what we see on one side of our atmosphere, that she cannot have any atmosphere."

Although it is shown that the want of detecting the effects of refraction is no ground for assuming that the moon has no atmosphere, yet it might be argued, on the other side, that we have no proof that she has an atmosphere. I think there are strong indications of the moon being enveloped in an atmosphere like our own. It must be remembered, in the first place, that the *dense* atmospheric coating of our own earth is not very thick, probably not exceeding, in proportion to the apparent diameter of the moon, five seconds of a degree. Therefore, if we be desirous to investigate this question minutely, we must observe the occultations closely, and in a clear and tranquil atmosphere. During occultations, it has been frequently observed that the star appears to advance actually upon and, as it were, *within* the disc of the moon before it disappears, and that sometimes to a considerable depth. This appearance proceeds, doubtless, either from clouds or mirage on the moon. Again, during solar eclipses we have strong indications of lunar atmosphere, as nothing else can satisfactorily account for the phenomena of "beads" and the "rose-coloured prominences" on various parts of the circumference of the moon. They can only be referred to the effects of a kind of mirage produced by the atmosphere of the moon. The narrow illuminated crescent seen a few days after the change, is, as it were, lifted, doubtless from the same cause. We have scarcely any opaque clouds above five miles in

height; therefore, as five seconds represent five miles at the distance of the moon, we must confine our observations within that narrow limit to ascertain whether the moon has clouds or not. The dark parts appear to be the dry lands, and the bright the seas. When at high elevations above the Caribbean Sea, we can plainly see the bottom; in like manner, we see the bottom of the lunar seas and not the water, more especially near the centre; but this appearance has made some to suppose that the bright parts are plains or dry lands.

The polar axis of the moon has nearly double the obliquity of that of the earth. The same pole is always visible to us, which in the clear atmosphere of the Tropics frequently presents most beautiful radial lines from the polar focus, representing the appearance of an illuminated melon. The visible pole of the moon always corresponds with our south polar axis: hence in this latitude, when the moon is in the meridian, the visible pole is seen below; and when we look at the moon in Tasmania, we see the pole above. Mr. De la Rue's beautiful photograph of our satellite shows her polar structure well when seen through an illuminated glass picture.

I remain, Sir, yours respectfully,

Oct. 7. E. HOPKINS, C.E. F.G.S.

BRIGHT SPOT ON THE MOON.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—The bright spot on the surface of the *Mare Crisium*, to which Mr. Herbert Ingall has called the attention of your readers, is an old acquaintance, as I have noticed it at intervals during the last five years and a half. I was at first greatly struck with it, as I could find no traces of it either in Schröter's drawings or on Beer and Mädler's Map. I, however, kept it under my eye; and if you will permit me, I will now communicate the extent of my knowledge of it.

I am uncertain, from Mr. Ingall's letter, as to the extent (as he saw it) of the spot in question, especially as the moon, being past full in October, the terminator must have been but little to the west of the *Mare Crisium*; while in May, when the moon was between the first quarter and opposition, the illumination would have been different. The spot has presented itself to me under *two* aspects. In the first instance, between the first quarter and full, I have recorded it as a *white cloud-like* marking west of the crater "Picard." It did not appear to possess a very definite outline; nor could I ascertain for some time if it were dependent on any difference of level of that portion of the *Mare* in which I saw it.

In the course of my observations, as I viewed the locality under an oblique illumination, this *white cloud-like spot* either became invisible or did not exist, which, I cannot say, and I was somewhat disposed to regard it as a "ground marking," so common in many other parts of the moon, and seen only under high illuminations; but its want of definiteness, and its similarity in appearance to a cloud, led me to

hesitate before expressing an opinion as to what it really appeared to be. Further observations brought to light a *small* pit-like depression in its neighbourhood, and with which the *larger* cloud-like marking appeared to be connected.

About twelve months ago I drew up a short paper on the physical characters of the *Mare Crisium,* in which I allude to the two spots above mentioned. This paper has not been published, as it is not yet sufficiently completed for the purpose. I may, however, quote that portion of it relative to the appearances in question.

As the sun rises higher upon the *Mare,* certain dots and streaks of light become very numerous, giving to the surface of the *Mare* a somewhat unsettled appearance; and a whitish cloud, exceeding the crater "Picard" in size, is seen to the westward of it. This cloud-like appearance is not seen when the sun is low in the horizon of the *Mare,* and disappears shortly before sunset. When it has disappeared, a small pit-like depression has been observed in its locality. This pit-like depression is of a beautiful whiteness, and is marked I.Cμ^2 in my catalogue of lunar "objects."

In the very interesting *geological* address of the President of the British Association for the Advancement of Science at the late meeting at Bath, a passage occurs which forcibly brought before my mind, when I heard it, the white cloud-like appearance, as associated with the pit-like depression. It is this: "On the site of the hot springs was a large morass, from which clouds of *white vapour* rose into the air." I forbear comment; nor do I quote this with a view to *theorise,* but simply to indicate the impression which the passage made on my mind in connection with these lunar phenomena.

It appears that Lohrmann noticed one, if not both, of these phenomena, for he has a brighter marking in his map on the surface of the *Mare Crisium* a little west of Picard, which would, however, I apprehend, be taken for a short mountain-range rather than for the appearance with which I am familiar. Schröter, in his second volume, shows, I believe, a *depression* here when the terminator is very near, but not the small pit-like marking as described above.

I trust this letter will not in the least degree deter Mr. Ingall from very closely observing the locality under all illuminations. The degree of brightness which he gives is about 6° or 7°. A careful determination of this element will be very valuable, as, I believe, Mr. Ingall's estimations are the only ones on record. The few estimations of brightness which I have yet made do not include I.Cμ^2.

I am, Sir, your obedient servant,

W. R. BIRT.

Victoria Observatory, Victoria Park, London, N.E.:
November 2, 1864.

P.S.—I am happy to say that I have now under examination one of the enlargements on glass (8-inch) of Mr. De la Rue's photograph, and find it especially useful for studying at complete leisure the lunar features thereon depicted. I anticipate some very valuable results both as regards the relative positions and relative brightness of objects, as well as many other interesting particulars.

THE MOON CONTROVERSY.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—A few years ago the Moon Controversy was started in Birmingham at the Philosophical Institution by the late Jelinger Symons, one of the greatest non-rotation champions of modern times. He and a few ardent followers defended their position with wonderful spirit against great odds for several nights. So exciting was the contest, that it extended into the local papers, and eventually into *The Times*; and even the Astronomer Royal was at last aroused, and wrote a long letter to that journal in defence of the orthodox view.

The debate ended in Birmingham, as it seems likely to end in your columns, by each side holding fast to its cherished opinions.

One of the most amusing features of the Controversy here was the oddity of the various machines which were brought forward in illustration of the rival theories. The most singular of these was one precisely similar to a gallows. There was the vertical post planted in wooden stage; an extended arm, which was propped up by a diagonal support; at the extremity of the arm was fastened a rope, and at the end of the rope was suspended a globe. The gentleman who exhibited this comical illustration laboured fervently, amidst considerable merriment, to render his meaning intelligible to the audience, many of whom, I am sorry to say, only rewarded his efforts by exclaiming, "I'll be hanged if I can understand him."

After so much ably said on both sides by your various correspondents touching this tiresome Controversy, it were almost useless to add more. The following hints, however, may go for what they are worth:—

Had the moon rotated the *contrary* instead of the *same* way with her orbital motion (the periods being as at present coincident), no doubt could have existed about the reality of rotation, for the entire surface of the moon would have been presented to us every month. Now, it would seem rather strange to admit a rotation when performed one way, and then deny it altogether when performed in the opposite. One might as well almost say, "When you turn to the left hand, you *do* turn; but the moment you begin to turn to the right hand, you don't turn at all, but stand stock-still!"

If the nearest satellite to Jupiter turn upon its axis like our moon, the inhabitants of Jupiter will, of course, only see the side next to them, and may, like the non-rotation people, here assert that it has no rotation, but the inhabitants of the other satellites will see the rotation clearly enough; and so on of the rest.

If a planet exist within the orbit of Mercury, the period of whose revolution is equal to that of the sun's rotation, the inhabitants of the planet might conclude that the great orb that fills so much of their sky was without rotation. The inhabitants of more distant planets perceive, notwithstanding, that it is ever slowly turning.

Almost any number of instances may be imagined, in which rotation may be so masked by the position of the observer as not to be perceived.

Yours faithfully,

Birmingham: Oct. 12, 1864. FREDERICK BIRD.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—On page 191 of your present volume, in answer to some queries on page 138, your correspondent Q. E. D. admits rotation on an axis to mean, on an axis *within the body*. But he misunderstands my second question; for let us, for instance, look at Saturn's ring while rotating. Now, if any one point on the edge presented to us passes from left to right, any other point at the other edge will necessarily pass from right to left. One point *can* therefore travel in one direction and another point in an opposite direction in a rigid rotating body. Q. E. D. evades the third query by answering it as if it referred to a *travelling* and not a *rotating* body; but I think if he will honestly answer the question, he will admit that a person on the outside of a rotating body must see every object at a distance apparently travelling in an opposite direction. If any object should continually appear in one position, there are but two explanations of it, viz.,—either that the first body on which the spectator is placed does not rotate, or that the second body which appears to keep its position revolves round the first in exactly the same time as the first rotates.

Obediently yours,

London: September 1864. QUERY.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—Unwilling to prolong the Moon Controversy, which appears likely to end by each person resolutely continuing in his own view of the question, I must yet claim your indulgence to reply to Mr. Dawes' remark on that portion of my letter which refers to *giddiness as a proof of rotation*. Giddiness will undoubtedly be produced by rotation; but as it also arises from other causes—for instance, from revolving in a small circle, from swinging, from travelling on board a vessel, &c.—it cannot be cited as a *proof* of the existence of one particular cause. Although, therefore, it is not a *proof* of rotation, it is really a consequence which follows when anyone rotates on his axis, or revolves in a small circle; but were it a proof of rotation, then it follows that where there is no giddiness there is no rotation; and it does not occur at all when anyone describes a very large circle after the manner of the moon. I must submit, therefore, that my objection to such a proof does not deserve to be called "frivolous."

I am, Sir, obediently yours,

Cambridge. AN ENQUIRER.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—Will any of your voluminous correspondents answer the following question by a simple Yes or No. I want no more, as many words only lead to confusion.

If I fill a humming-top with peas, and cause the top to revolve, it (the top and peas as one body) revolves on an axis. Does each pea revolve at the same time on an axis of its own?

Yours, &c.,

Heckington Hall, Lincolnshire: W. LITTLE.
Nov. 1864.

THE MOON CONTROVERSY: AND *SOMETHING NEW!*

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—I had hoped not to trespass on your space again respecting the moon. I think you are right in regarding the record as well-nigh closed. But I do find there is a telling argument not yet put forward, which I shall now briefly state. Before doing so, however, let me say to Mr. Dawes, in reply to his allusion to one of my arguments, that I do not object to his saying the orange held fast in my hand "rotates" with my body, *if* he will not say that it *both* revolves *and* rotates. I think "revolves" the proper word in that case; but I misused that word myself in the conclusion of my last letter. There I ought to have said *one quarter rotation*, and not "revolution." So let bygones be bygones.

My new argument is this: Let a revolving body rotate four times on its axis each complete revolution it makes. If it goes from west to east horizontally, and begins with its face to the east, then when it reaches the north (*i.e.* has made one quarter revolution), it will again look to the east; again it will look east when it has reached the most westerly point, and again when at the south; and finally, once more when it arrives at the point in the east it started from. But besides these four axial turnings, it has gone round (*i.e.* revolved) in a circle; and if going round in the circle implies *rotation as well as* revolution, then as $4+1=5$, the body has turned *five* times on its axis. But $5\times4=1\frac{1}{4}$; and, in that case, the face of the body could not be turned *eastward* at each cardinal point, which is the result of only four complete rotations, *one precisely every quarter of the orbit.* Conversely, if a body so turns round on its axis completely once, and no more, every quarter "revolution," it turns four times round in all when the whole revolution is complete, and *not five times.* Therefore, &c., Q.E.D.

It may help those who wish to continue the argument further (and elsewhere, if the *Register* now closes the subject) if I add that in rotation about an axis every point on one side of the axis diametrically opposed to another on the other side, moves in an opposite direction to such other point. But the face of the moon does *not* move in an opposite direction to the back of the moon, regarding the earth as a fixed point; both move *direct* and in parallel lines; therefore the moon does *not*, on that hypothesis, *rotate.* Q.E.D.

But the "Something New" with which I propose to enliven this discussion is the following extract from a perfectly new astronomical work, called *The Simplicity of the Creation.* The simplicity is very admirable, no doubt! The author first quotes this quotation in *Baby Worlds* (which is funny enough):—

"The doctor depicts the inhabitants of the moon as endowed by nature with more than eagles' eyes, an untiring frame of body, and an extraordinary elasticity of motion; and he expresses the confident opinion that 'that most splendid observatory in the entire solar system,—the lunar hemisphere turned away from us,—cannot well have the worst set of astronomers attached to it.'"

And then the author of *The Simplicity* goes on:—

"From this I cannot differ, for there ARE astronomers on the other

side of the moon, and that we know nothing of them arises entirely from their over-great humility; they do not wish to be spoken of. [!]

"The immense apertures of our satellite, generally believed to be extinct craters of volcanoes, are nothing but the mouths of tubes passing from the other side of the moon to ours; and through these lunar telescopes the men of science above watch our proceedings here below, and naturally those of their *confrères*." (pp. 157, 158.)

I am sorry to stop the quotation, but I know the limits of your space. I commend this author's views to Mr. Birt and Mr. Webb. It looks very like a joke; but there is not the slightest indication that the author is not as sincere in what he writes as he is simple!

Yours faithfully,
NAUTICUS.

At Sea: Nov. 8, 1864.

ε LYRÆ.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—The two small stars in the system of ε Lyræ, just S. of Sir J. Herschel's "debilissima couple," referred to in your last number by the Rev. H. C. Key, were first seen by me in the beginning of April 1858, with an achromatic telescope of 8-inch aperture and 12-feet focus. In 1861 I frequently, on fine nights, saw them with a 6-inch aperture achromatic of 8½-feet focus, and I can imagine their visibility to an acute eye with a still smaller refractor of first-class workmanship.

I am, Sir, yours truly,
WM. WRAY.

1 Clifton Villas, Highgate Hill, N.:
Nov. 15, 1864.

SMALL STARS NEAR ε LYRÆ.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—For the Rev. H. C. Key's information, I beg to state that in 1855 Mr. Lassell gave me a list of test-objects for a 12-inch speculum on which I was then at work, and amongst others ε Lyræ, saying, that "there were other minute stars between the two pairs beside the debilissima couple." I saw three; and on giving my diagram to Mr. Lassell, he said that he had seen two with his 9-inch telescope, and the third was visible with the 24-inch mirror.

The third star is a little further outwards from the "debilissima couple" than the two mentioned by Mr. Key. This evidence may serve for comparison of glass and metallic specula, and is all the more interesting, owing to the mirrors being of the same size—both 12-inch mirrors.

Yours faithfully,
JOHN WATSON.

Washington Chemical Works,
Durham: Nov. 15, 1864.

TO THE EDITOR OF THE ASTRONOMICAL REGISTER.

Sir,—In the Astronomical Register for this month there is a letter from the Rev. H. C. Key, stating the performance of his silvered glass reflector on the group designated by Bayer as ϵ *Lyræ.** He wishes "to know with how small an aperture they" [some very small stars in the group] "can be seen in a good achromatic, as it would afford a good test of the relative illumination of the achromatic and the silvered glass reflector."

The enquiry is very interesting; but unfortunately there is no small difficulty in coming to a satisfactory conclusion, arising chiefly from the fact that there is a far greater difference than is usually recognised in the sensitiveness of human eyes to the impression of extremely faint points of light. One of the most remarkable instances of it is furnished by this very group forming ϵ *Lyræ.* In the *Phil. Trans.* for 1824, part 3, p. 313, Sir John Herschel, describing the faint couple between the two double stars, ϵ^1 and ϵ^2, which he termed "*Debilissima,*" says "Its existence cannot even be suspected with either of the two equatoreals": [a 5-foot achromatic of 3·8 inches aperture, and a 7-foot of 5 inches.] "The 7 and 10-feet reflectors (the former of 6, the latter of 9 inches aperture) in like manner fail to give any indication of it," etc.

On referring to my astronomical journals I find the following entries:—

"1828. September 8.—With a 7-foot Newtonian of 7¼ inches aperture, by Mr Lassell.—ϵ *Lyræ*....The small star usually seen appeared bright; and two others considerably smaller, as in the diagram, between the double stars."

These were the "debilissima" couple, of whose existence I was not previously aware, not having met with the *Phil. Trans.* for 1824 until the following year.

"1829. March 24.—ϵ *Lyræ.* Though the object was several hours from the meridian, the excessively minute stars between the two double sets were steadily visible. The preceding one is the brightest." [With the 7-foot Newtonian, aperture 6¼ inches.] On 1829, August 4, the "debilissima" was seen with the same telescope by a friend observing with me, who described them as "excessively minute."

"1829. August 9.—ϵ *Lyræ.* The 'debilissima' strikingly evident with aperture 6¼, and Huyg. 120. Much brighter stars than that near α^2 *Capricorni,*" [which had been previously seen with the same Newtonian.]

"1830. April 20.—ϵ *Lyræ.* Star low; altitude 22 degrees, more or less. With Dollond's 5-foot achromatic, aperture 3·8 inches, negative 140. The 'debilissima' perceivable; the preceding one being the brightest. Also *two or three excessively faint stars preceding the 'debilissima.'*" [Figure 1.]

"1830. April 28.—ϵ *Lyræ.* About four hours from the meridian: negative 140 [on the 5-foot achromatic] shewed the 'debilissima' distinctly; and there are several very minute stars preceding them." [Figure 1.]

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* The designation ϵ *Lyræ* properly includes *both* the close doubles, which are most correctly distinguished as ϵ^1 and ϵ^2; or as 4 and 5 *Lyræ,* if Flamsteed's numbers are used. Argelander, with his usual accuracy, has so termed them in his *Uranometria Nova.* To most eyes they appear as a single star of the 4th magnitude.

"1833. September 22.—At Bedford, Capt. Smyth's Observatory; himself present. With 8½-foot achromatic, aperture 5·9 inches. ϵ *Lyræ.* Two or three stars distinctly seen, preceding the 'debilissima.'" A diagram, [see Figure 2] made at the time contains *four*, situated as I have always seen them, with object glasses from 6¼ to 8¼ in. aperture.

Figure 1.

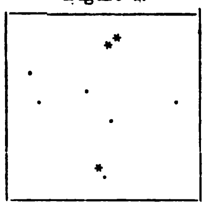
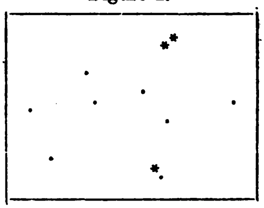


Figure 2.



On the 3d of this month I observed the group with an 8 inch object glass by Cooke, and noted the places of the two especially to which Mr Key refers: they were easily seen, and bore some illumination. The northern one was observed to be precisely in the line drawn through the close equal pair ϵ^2, and produced towards the N. W.; and the southern one nearly in the line from the 9th mag. star following the "debilissima," through the southern star of the debilissima, and produced towards the S. W. These must, I think, be the pair seen by Mr Key, as "they form an isosceles triangle with the southernmost of the [debilissima] couple," though I should not have described their situation as "just to the south of the southernmost of them." The northern one of them is in fact a little *north* of that star. I see no others to the south of these.

Hoping that other observers will send you their "seeings" of this object, and that some trustworthy comparisons may thus be arrived at, I remain,

Hopefield Observatory, Your obedient servant,
Haddenham, Bucks: W. R. DAWES.
1864, Nov. 18.

THE PLANETS FOR DECEMBER.

Mercury arrives at its greatest easterly elongation on the 22nd of the month, setting after the sun on the 1st about a quarter past 4, and on the 31st about a quarter past 5. It is in Ophiuchus at the beginning, and on the borders of Capricornus and Sagittarius at the end of December.

1st	R.A.	17 21 24	Dec.	S.	25 10½	Diameter	4″·8
31st	„	19 47 59	„	S.	20 29½	„	8″·8

Venus is now becoming a conspicuous object in the south-west, not setting until 6 o'clock on the 1st, and half past seven on the 31st of the month. It is in Sagittarius at the beginning, and on the borders of Capricornus and Aquarius at the end of the month.

1st	R.A.	19 1 24	Dec. S.	24 36	Diameter	12″·8
31st	,,	21 33 22	,,	16 25½	,,	15″·0

Illuminated portion of the disc of Venus=0·786.

Mars still reigns supreme during the night—rising in the afternoon, and not setting until the morning. It continues in Taurus.

1st	R.A.	4 29 5	Dec. N.	23 43	Diameter	16″·4
31st	,,	3 56 7	,,	23 1	,,	13″·4

Illuminated portion of the disc of Mars=0·989.

Jupiter is in the constellation Ophiuchus, but too near the sun to be observed with any satisfaction.

1st	R.A.	16 28 10	Dec. S.	21 12½
31st	,,	16 56 29	,,	22 7

Saturn rises about half past 3 in the morning at the beginning, and about 2 o'clock at the end of the month: it remains in the constellation Virgo.

1st	R.A.	13 42 0	Dec. S.	8 5½	
31st	,,	13 51 34	,,	8 53½	Diameter 15″·0

Dimensions of Ring: Outer Major Axis, 37″; Outer Minor Axis, 10″.

Uranus is now well fixed for observation, remaining, like Mars, visible the whole night; it is in opposition on the 19th, continuing in the constellation Gemini.

2nd	R.A.	5 52 9	Dec. N.	23 38½	Diameter	4″·2
30th	,,	5 46 59	,,	23 37½	,,	4″·2

THE MINOR PLANETS.

The following are the Minor Planets which will be on, or within one hour of Right Ascension on either side of, the Meridian, between nine and twelve o'clock during the evenings of December. Their places are to be found in the *Supplement* to the *Nautical Almanac* for 1867.

	Magnitude.		Magnitude.
Fortuna	9·0	Fides	9·4
Lutetia	11·4	Leda	10·5
Proserpine ...	11·2	Alexandra ...	12·3
Euterpe	8·8	Echo	11·7
Amphitrite ...	8·9	Maximiliana ...	11·9
Polyhymnia ...	11·1	Clytie	—

ASTRONOMICAL OCCURRENCES FOR DECEMBER, 1864.

DATE.		h. m.	Principal Occurrences.	Jupiter's Satellites.		Meridian Passage. h. m.
Thur	1	 14 44	Sidereal Time at Mean Noon, 16 42 22·6 Conjunction of Moon and Venus, 6° 42′ S.	The Satellites are invisible this month, Jupiter being too near the Sun.		Mars. — 11 44·0
Frid	2					11 38·4
Sat	3					11 32·8
Sun	4	9 4 9 34	Occultation, c^1 Capricorni (6) Reappearance of do.			Moon. — 4 34·1
Mon	5	8 35 9 29 19 34	Occultation, κ Aquarii (5) Reappearance of ditto Moon's First Quarter			5 25·9
Tues	6					6 17·1
Wed	7					7 8·3
Thur	8					8 0·2
Frid	9					8 53·4
Sat	10					9 47·9
Sun	11	13 11	Conjunction, Moon and Mars, 4° 35′ N.			10 43·3
Mon	12	19 12	Full Moon			11 38·8
Tues	13	6 8	Conjunction of Moon and Uranus, 4° 5′ N.			12 33·3
Wed	14	18 2 18 52	Occultation, λ Geminorum Reappearance of do. (3½)			Mars. — 10 33·6
Thur	15					10 28·5

DATE.		Principal Occurrences. h. m.		Jupiter's Satellites.	h. m. s.	Meridian Passage. h. m. Mars.
Fri.	16	 9 41 10 46 15 31 16 7	Sidereal Time at Mean Noon 17 41 31·0 Occultation of A^2 Cancri Reappearance of do. (6) Occultation of 60 Cancri Reappearance of do. (6)			10 23·4
Sat.	17					10 18·4
Sun	18	14 5	Opposition of Uranus			10 13·4
Mon	19	14 48 16 0	Occultation of p^5 Leonis Reappearance of do. (5)			10 8·5
Tues	20	17 3	Moon's Last Quarter			10 3·6
Wed	21	13 20 14 16	Occultation of 28 Virginis Reappearance of do. (6)			9 58·8
Thur	22	4 3	Greatest Easterly Elongation of Mercury, 19° 52′			9 54·0
Fri.	23	5 15	Conjunction of Moon and Saturn, 3° 20′ N.			9 49·3
Sat	24					9 44·7
Sun	25	19 3	Near approach of Moon to ν Scorpii (4)			9 40·1
Mon	26	16 32	Conjunction of Moon and Jupiter, 2° 30′ S.			9 35·6
Tues	27					9 31·2
Wed	28	9 21 13 8 21 32	New Moon Conjunction of Venus and ι Capricorni, 7m·1 W. Conjunction of Venus and γ Capricorni, 9m·1 E.			9 26·7
Thur	29	16 59	Conjunction of Moon and Mercury, 4° 48′ S.			9 22·4
Fri.	30	5 46	Conjunction, Venus and δ Capricorni, 9m·8 E.			9 18·1
Sat	31	13 56	Conjunction of Moon and Venus, 7° 1′ S.			9 13·9

TABLE OF NEBULÆ.

Right Ascension, One Hour.

NAME OF NEBULA	Right Ascension.	Declination.
100 Hersc. I Ceti .... Small, round, and somewhat faint.	1 24 35	− 7 34
33 M. Trianguli .... Large and distinct, though not bright.	1 26 15	+29 59
76 M. Persei .... A fine and curious object, with indications of a double nucleus.	1 33 50	+50 54
112 Hersc. I Arietis ...... Dim and uninteresting.	1 51 55	+18 21

The second and third objects in our list of nebulæ for the First Hour of Right Ascension will best repay the observer for his scrutiny of them; 112 Herschel I Arietis, though of some size, being pale and of little interest, and 100 Herschel I Ceti, a small round nebula condensing towards the centre, being quite dimmed and made faint by the 9th magnitude stars which are in the field with it. 33 M. Trianguli, though not very bright, is distinct and easily seen; there are some exceedingly minute stars in and upon it, (though disconnected with it,) which, glimpsed by the averted eye, give it the aspect of resolvability. 76 M. Persei is very fine and curious; bright and of a mottled aspect, with indications of a double nucleus or central constriction, it is like a miniature of 27 M. Vulpeculæ, the so called "dumb bell nebula." 76 M. is in a rich and beautiful field of stars.

Astronomical Refractor, focal length 4 feet, aperture 3⅜ inches, complete, on a Portable Universal Equatoreal Stand. [3]

Achromatic Refractor, 44 in. focus, 3½ in. aperture, on a Fraunhofer's Universal Equatoreal Stand. [7]

Achromatic Refractor, 4 ft. 6 in. focal length, 3½ in. aperture, by *T. Cooke & Sons,* Equatorially mounted, on tripod stand. [36]

Achromatic Refractor, 4 ft. focal length, 3 in. aperture, on brass tripod stand, with achromatic finder, 3 celestial and 3 terrestrial eye-pieces, &c. [20]

Newtonian Reflector, 7 ft. focus, 7½ in. aperture, eight eye-pieces, powers from 30 to 360, Equatoreally mounted. [11]

Transit Instrument, 5 ft. focus, 3¾ in. aperture, Ys fitted with agates, for mounting on stone piers. [29]

Equatoreal Mounting, (for Latitude 51 or 52), adapted for a telescope of 6 or 7 foot focus.—12 inch Circles, Driving apparatus, &c., all of the most approved construction. [5]

Improved **Varley Stand,** with rackwork movements, adapted for a telescope of 5 or 6 ft. focus: fixed upon a circular turn-table, so as to be easily pointed in any direction. [16]

Astronomical Observatory, built of wood, 16 feet by 8 feet, adapted for Equatorial, Transit, and Clock; could be easily removed. Price moderate. [38]

Recreative Science: complete in numbers, half-price. [30]

TELESCOPE FOR SALE.—One of Messrs. SOLOMON'S £5 ASTRONOMICAL REFRACTING TELESCOPES to be SOLD, nearly new.—Focal length, 44 inches; clear aperture, 2¾. Price Four Guineas, with terrestrial eye-piece, table tripod stand, and box, complete. [31] H

FOR SALE—an excellent REFLECTING TELESCOPE, focal length 7 feet, aperture 7½ inches, mounted so far Equatoreally that with a little care it may be turned on a star or planet in the day time.—Four Eye-pieces.—Price £20 only, (less than the cost of the stand,) the proprietor having mounted a larger instrument. [11] F

ACHROMATIC TELESCOPE FOR SALE, 10 ft. focal length, 6 in. clear aperture, by *Goddard,* with finder of 2 in. aperture, six eye-pieces, powers from 20 to 1000, mounted on a mahogany stand upon a new and improved principle.—Apply to Mr S. Corke, Auctioneer, &c., Sevenoaks, Kent.

INSTRUMENTS, &c., WANTED.

Achromatic Object Glass, Wanted, from 4 to 5 inches clear aperture, ready fitted in cell, second hand, cheap. [37]

Equatorial Stand, Wanted—adapted for a 5 ft. Refractor, with graduated circles; second hand, at a moderate price. [35]

Monthly Notices of the Royal Astronomical Society.—The third Volume wanted: a good price will be given. [26]

CORRESPONDENTS' QUERIES.

Have any parts of Mr Pogson's Atlas of Variable Stars yet been published? Also, what is the full title of Auwer's Catalogue of Nebulæ? •J. T. B.

Might I suggest through the medium of your Register, that a short account of the production of Lunar Photographs, by some one practically conversant with the subject, would be highly interesting to some of your readers? T. W. C.

If the Rev. W. R. Dawes, or any other observer with a good instrument, would suggest, for the information of those who possess inferior means, what to look for on the Planet Mars, he would oblige others, besides Yours faithfully, P.

ASTRONOMICAL REGISTER.

LIST OF SUBSCRIBERS—Names received since our last number.

Lawton, W. Esq., 144, High Street, Hull.
Matthews, W. Esq., Hill House, Gorleston, near Yarmouth, Norfolk.
Waller, T. H. Esq., 20, Bootham, York.
Williams, Rev. W. O., Pwllheli, Carnarvonshire, North Wales.

ASTRONOMICAL REGISTER—Subscriptions received by the Editor for 1864.

To December.		**To March, 1865.**	*Also Received by the Editor:—*
Howlett, Rev. F.	Pritchard, Rev. C.	Birt, W. R.	Compton, A.J.S., 6*s*.
Jones, W. C.	Watson, J.	Burr, T. W.	Oldfield, W., 3*s*.
Little, W.	Williams, Rev. W. O.	Hunt, G.	Wilson, T., 3*s*.
Maclear, Sir T.	Williams, G., Holloway		
Milner, Rev. J.	Vertu, J.		

Nov. 26. 1864.

NOTICES TO CORRESPONDENTS.

The paper on "The Dates preferred by Fireballs," by Mr A. S. Herschel, arrived after the Register had gone to press: it will appear in our next.

Letters from "Academicus" and "P." are in type, but deferred with several other papers from want of space.

We have to acknowledge the receipt of the "Astronomical Observer," by the Rev. W. A. Darby—"Rates of Chronometers at Greenwich for 1864," from Mr C. M. Frodsham—"Report of the Astronomer Royal for Scotland," from Professor C. P. Smyth—and a drawing of the Planet Mars, from Mr N. Green.

The following eight pages, on *Simple and Compound Motion, &c.*, are presented to the readers of the Register by Mr H. Perigal.

The Astronomical Register *is intended to appear at the commencement of each month: the Subscription (including Postage) is fixed at* **Three Shillings** *per Quarter, payable in advance, by postage stamps or otherwise.*

The pages of the ASTRONOMICAL REGISTER *are open to all suitable communications: Letters, Articles for insertion, &c., may be sent to the Editor*, MR S. GORTON, Stamford Villa, Downs Road, Clapton, N.E., **not later than the 20th of the month.**

To the Editor of the Astronomical Register.

REVOLUTION AND ROTATION.

SIR,—Instead of replying to *arguments* that have been repeatedly *confuted*, and disproving *assumptions* well known to be fallacious and untenable, I think it will tend more to the elucidation of the subject if you will allow me room in your pages for the accompanying diagrams, which exhibit to the eyes as well as to the understanding of your readers some of the REALITIES of MOTION; the figures, traced by the *lathe*, being the actual results of the specified movements.

The Bicircloid Curves are selected as some of the simplest examples of *double motion*: and each of the diagrams indicates the characteristic peculiarity of the kinematic law* it represents. They exhibit the paths described in space by the particles of a body in either of the three *simple movements*, or in one of the *double motions* selected—so that your readers, whether mathematicians or non-mathematicians, may judge for themselves as to which motions are simple or single, and which are double—when I explain how very easily they may test the distinctive effects of a simple movement or of double motions, from the respective paths described by the moving points or component particles of the bodies in motion.

First, it may be remarked that when a body has but *one movement*, the paths of its particles do *not* intersect either their own path or those of the other particles—whereas, if the body has a *double* motion, its particles move in paths which intersect all the others, besides that of the center of the body.

Secondly, axial rotation may be readily distinguished from orbital revolution, from the characteristic peculiarities of the two ways of turning round, viz., that when revolving (only), all the particles are alike moving in the same direction: but, when a body turns round its own axis or center of gravity, although all the rotating particles move round the common center in the same *angular* direction, yet two particles at opposite ends of any diameter (at right angles to the axis) are at every instant moving in exactly opposite directions in space. For instance, if the one particle is moving from West towards North, the other will be moving from East towards South—just as the hands of a clock, when half an hour apart, say at a ¼ before 3, are (for a while) moving in contrary directions, so far as the hour-hand is moving downwards while the minute-hand is moving upwards, though both are turning round in the same direction. Again, when two children are playing at seesaw, at each end of a plank, the one goes up as the other goes down.

The repeated discussions of late years have so widely and thoroughly exposed the fallacy of the Moon's alleged rotation, and the erroneous assumptions upon which it is based, that I trust the dogma will soon die a natural death; and that its few remaining adherents will yield to the 'inexorable logic of facts' and amend their doctrines in preparation for the Reforms that will follow in due course.

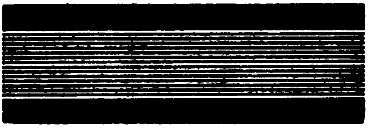
* Kinematics is the Science which treats of the *effects* of Motion; Dynamics treats of the *causes* of Motion, or of the *forces* which produce Motion.

SIMPLE MOVEMENTS.

A BODY has one movement (only), and therefore is in ***simple motion,*** when all its particles move with uniform velocity in one direction :—either in parallel straight lines, if the movement is simply rectilinear; or, if it be circular, in parallel *i. e.* in concentric circles with uniform angular velocity round a fixed center.

The simple circular motion may be *axial* or *orbital.* If all the circles are included in the same space which the body occupies when at rest, the movement is *axial* and is called ROTATION. When the concentric circles are all larger than the circumference of the body, the movement is *orbital* and is called REVOLUTION.

Rectilinear Motion.



$y=b.$

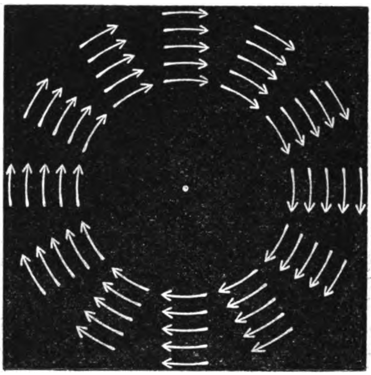
Axial Rotation.

$\theta=\phi; \quad \psi=\phi.$

Orbital Revolution.

$\theta=\phi; \quad \psi=0.$

Orbital Revolution.



$\theta=\phi; \quad \psi=0.$

COMPOUND MOTION.

When the particles of a moving body describe in space lines which intersect,—the body has a *compound motion*: their angular velocity is variable; and not constant round any fixed point, as in simple circular motion.

DOUBLE CIRCULAR MOTION.

ELEVENTH BICIRCLOIDS. TWELFTH

$V : \mathbf{V} = 4 : 1$ or $4 : 3$, inv.

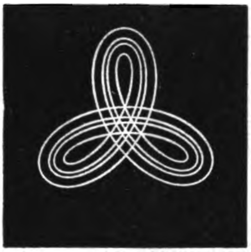
$\theta = \phi - \psi$; $\sin \psi = \frac{e}{r} \sin 4\phi$.

$V : \mathbf{V} = 4 : 1$, dir.; or $4 : 5$, inv.

$\theta = \phi + \psi$; $\sin \psi = \frac{e}{r} \sin 4\phi$.

SIXTH BICIRCLOIDS. SEVENTH

$V : \mathbf{V} = 3 : 1$ or $3 : 2$, inv.



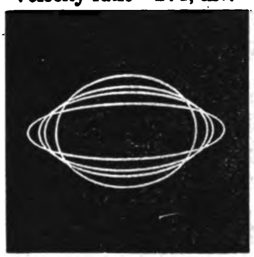
$\theta = \phi - \psi$; $\sin \psi = \frac{e}{r} \sin 3\phi$.

$V : \mathbf{V} = 3 : 1$, dir.; or $3 : 4$, inv.

$\theta = \phi + \psi$; $\sin \psi = \frac{e}{r} \sin 3\phi$.

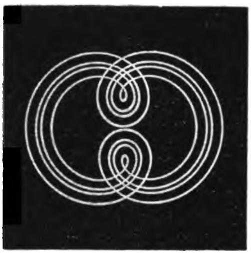
THIRD BICIRCLOIDS. FOURTH

Velocity-ratio $= 2 : 1$, inv.



$\theta = \phi - \psi$; $\sin \psi = \frac{e}{r} \sin 2\phi$.

$V : \mathbf{V} = 2 : 1$, dir.; or $2 : 3$, inv.



$\theta = \phi + \psi$; $\sin \psi = \frac{e}{r} \sin 2\phi$.

FIRST BICIRCLOIDS. SECOND

Velocity-ratio = 1 : 1, inv.	$V : \mathbf{V} = 1:1$, dir.; or $1:2$, inv.
	
$\theta=\phi-\psi$; $\sin\psi+\frac{e}{r}\sin\phi$.	$\theta=\phi+\psi$; $\sin\psi=\frac{e}{r}\sin\phi$.

General equations of Bicircloids.

$\psi=\mathbf{V}\phi\pm\theta$, $r\sin\psi=e\sin V\phi$, $r\cos\psi=1+e\cos V\phi$.
Whence $r^2=1+e^2+2e\cos V\phi$ and
$x=\cos\mathbf{V}\phi+e\cos(\mathbf{V}\pm V)\phi$, $y=\sin\mathbf{V}\phi+e\sin(\mathbf{V}\pm V)\phi$.

The rectangular coordinates x and y are measured from the center of the deferent. Radius of deferent $=1$, $e=$ epicyclic radius, and r the radius vector, $V\phi$ the epicyclic angle, $\mathbf{V}\phi$ the deferential angle, θ the vectorial angle, and ψ the difference between the deferential and vectorial angles; so that $\theta=\mathbf{V}\phi\pm\psi$, taking $+$ or $-$ according as the motion is direct or inverse.

To find x and y in terms of e and ϕ.

Take $x=r\cos\theta=r\cos(\mathbf{V}\phi\pm\psi)$, $y=r\sin\theta=r\sin(\mathbf{V}\phi\pm\psi)$;

Thus $x=r\cos\mathbf{V}\phi\cos\psi\mp r\sin\mathbf{V}\phi\sin\psi$,
$=\cos\mathbf{V}\phi\,(1+e\cos V\phi)\mp e\sin\mathbf{V}\phi\sin V\phi$,
$=\cos\mathbf{V}\phi+e(\cos\mathbf{V}\phi\cos V\phi\mp\sin\mathbf{V}\phi\sin V\phi)$,
$=\cos\mathbf{V}\phi+e\cos(\mathbf{V}\pm V)\phi$.

and $y=r\sin\mathbf{V}\phi\cos\psi\pm r\cos\mathbf{V}\phi\sin\psi$,
$=\sin\mathbf{V}\phi\,(1+e\cos V\phi)\pm e\cos\mathbf{V}\phi\,.\sin V\phi$,
$=\sin\mathbf{V}\phi+e(\sin\mathbf{V}\phi\cos V\phi\pm\cos\mathbf{V}\phi\sin V\phi)$,
$=\sin\mathbf{V}\phi+e\sin(\mathbf{V}\pm V)\phi$.

Also $r^2=x^2+y^2$. Thence results
$x=\cos\mathbf{V}\phi+e\cos(\mathbf{V}\pm V)\phi$, $y=\sin\mathbf{V}\phi+e\sin(\mathbf{V}\pm V)\phi$,
$r^2=1+e^2+2e\cos V\phi$.

Ex. 1.—Twelfth Bicircloid.

$4:1$ direct. $V=4$, $\mathbf{V}=1$.
$\theta=\phi+\psi\ldots r\sin\psi=e\sin4\phi$.
$x=\cos\phi+e\cos5\phi$, $y=\sin\phi+e\sin5\phi$;
$r^2=1+e^2+2e\cos4\phi$.

or $4:5$ inverse. $V=-4$, $\mathbf{V}=5$.
$\theta=5\phi-\psi$. $r\sin\psi=e\sin4\phi$.
$x=\cos5\phi+e\cos\phi$, $y=\sin5\phi+e\sin\phi$;
$r^2=1+e^2+2e\cos4\phi$.

Ex. 2.—Fourth Bicircloid.

$2:1$ direct. $V=2$, $\mathbf{V}=1$.
$\theta=\phi+\psi$. $r\sin\psi=e\sin2\phi$.
$x=\cos\phi+e\cos3\phi$, $y=\sin\phi+e\sin3\phi$;
$r^2=1+e^2+2e\cos2\phi$.

Companion to the ellipse.

Ex. 3.—Third Bicircloid.

2 : 1 inverse. $V=-2$, $\mathbf{V}=1$.

$\theta=\phi-\psi$. $r\sin\psi=e\sin 2\phi$.

$x=\cos\phi+e\cos(-\phi)$, $y=\sin\phi+e\sin(-\phi)$;

or $x=\cos\phi+e\cos\phi=(1+e)\cos\phi$,

$y=\sin\phi-e\sin\phi=(1-e)\sin\phi$;

$r^2=1+e^2+2e\cos 2\phi$.

Also $\left(\frac{x}{1+e}\right)^2+\left(\frac{y}{1-e}\right)^2=1$.

An ellipse, whose principal semiaxes are $1+e=$ apocenter, and $1-e=$ pericenter.

Ex. 4.—Second Bicircloid.

1 : 1 direct. $V=1$, $\mathbf{V}=1$.

$\theta=\phi+\psi$. $r\sin\psi=e\sin\phi$.

$x=\cos\phi+e\cos 2\phi$, $y=\sin\phi+e\sin 2\phi$;

$r^2=1+e^2+2e\cos\phi$.

Common Cardiode when $e=\frac{1}{2}$; and, when $e=1$, Trisectrix, whose polar equation is $r=2\cos\frac{\theta}{3}$.

Ex. 5.—First Bicircloid.

1 : 1 inverse. $V=-1$, $\mathbf{V}=1$.

$\theta=\phi-\psi$. $r\sin\psi=e\sin\phi$.

$x=\cos\phi+e\cos 0\phi$, $y=\sin\phi+e\sin 0\phi$;

or $x=\cos\phi+e$, $y=\sin\phi$;

$r^2=1+e^2+2e\cos\phi$.

Also $(x-e)^2+y^2=1$.

Annuloid, or excentric Circle.

Mathematicians will understand, from their own formulas, that every Bicircloid Curve must have one or more pericenters and as many apocenters: which non-mathematicians may recognize in each of the curves by observing their characteristic peculiarity of gradually approaching towards, and receding from, the center of the curve and also of the double movement. It is obvious that such cannot occur when the particles of a body all describe concentric circles: which, therefore, never can result from any double circular motion; as any mathematician ought to deduce from the equations to these curves.

As any particle of the body reaches its maximum, and also its minimum, distance from the center of the orbit as often as the body turns round its own center or axis of rotation, it is evident that the Curves described by each particle must have as many apocenters, and as many pericenters, as the number of times the body turns in completing its orbital movement: which, of course, is the same as V, the epicyclic *V*elocity. This will be apparent on inspection of the Diagrams, from the number of Loops &c. being in every case the same as the epicyclic *V*elocity V. The Curves will be seen to have 4, 3, 2, 1 Loops &c., and the epicyclic Velocities are 4 : 1, 3 : 1, 2 : 1, 1 : 1; the Curves of 2 and 1 *outward* Loops being represented by the Ellipse and Annuloid (excentric Circle). The Curve is completed in $\mathbf{V}$ revolutions of the Deferent radius, during which the Epicyclic radius makes V revolutions; or 2 V semi-revolutions, in each of which it passes through 180° of arc from an apocenter to a pericenter, or *vice versâ*. There are therefore in the Curve V apocenters, each $=1+e$, when $\cos V\phi=1$,

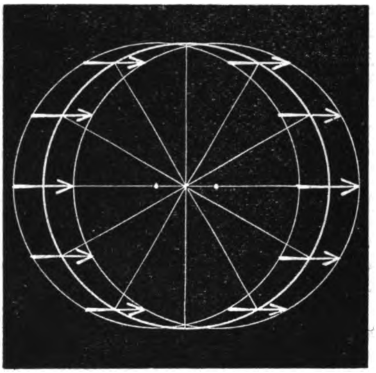
in the formula $r^2=1+e^2+2e\cos V\phi$; and V pericenters, each $=1-e$, when $\cos V\phi=-1$.

It is also evident that each time the body has completed an epicyclic movement about its own axis, all its particles must have crossed the Line of Centers of Deferent and Epicycle; each at its pericenter and at its apocenter. In so doing the Epicyclic radius will have coincided with the line of centers $2V$ times; V times on each side of the Epicyclic center. Consequently the body will have turned all parts of its periphery to the center of the Deferent V times, during **V** revolutions of the Deferent radius or Line of Centers.

When a body maintains its parallelism, while orbitating with its center in a circle, as a compass needle for instance when carried in a circle, it rotates on its axis with the same angular velocity in the contrary direction. Its North and South Poles each moving in a circle of the same radius as that in which the center is carried. This is the first Law of Double Circular Motion.

It may be observed that in its progress the center of the body always maintains the same distance from the center of orbitation; while its extremities periodically arrive at their maximum and minimum distance from the center of orbitation. This is a case that never happens when the motion is single; but always in double circular motion, of which it is a characteristic peculiarity.

Revolution and Rotation in contrary directions, with equal angular Velocities.



If straight lines be drawn from the center of the orbital movement to the points where the orbital circle cuts the middle of each Arrow, it will be noticed that these lines, each of which is a radius vector, will make with the Arrow the same angle that it makes with the horizontal diameter of the orbital Circle; showing that the angular velocity about the center of the Arrow is equal to that of the radius vector about the center of the orbital movement, but in a contrary direction. Therefore all the points in each Arrow describe circles of the same size as that in which its middle point is carried; and the motion is that of the first Bicircloid, the equations of which are $\theta=\phi-\psi$, $r^2=1+e^2+2e\cos\phi$, $r\sin\psi=e\sin\phi$, $r\cos\psi=1+e\cos\phi$; which give $x=r\cos\theta=\cos\phi+e$, $y=r\sin\theta=\sin\phi$, and therefore $(x-e)^2+y^2=1$; the equation of the Annuloid or excentric Circle.

ROTATION of the Moon.—"If we wish to determine either the fact or the velocity of its rotation, we must refer the direction of some produced radius of the body to some zero-point. We may take the *general* zero-point, or we may try to find a *special* zero-point. Now what shall that special zero-point be? Clearly the same which is the point of reference for all other rotations; namely, some point (as a Star) at a distance so great, that the motion of the Moon in going round the Sun does not sensibly disturb the direction of the line from the Moon to the Star."—"Having thus come to the point, that rotation is to be referred to something very distant, as a Star, and *not* to anything near, as the Sun or Earth, there is little difficulty in ascertaining from observable appearances whether the Moon does or does not rotate. Does she always turn the same part of her face to the same Star? No. Then she does rotate. If her face had been once turned to a Star, how long time elapses before it is turned to the same Star again? 27¼ days. Then 27¼ days is the time of her rotation."—(G. B. Airy to Jelinger Symons, 19 April 1856.)

This doctrine requires revision and amendment to make it accord with the *realities of Motion*. Taking the term *Rotation* (as used above) to be synonymous with *turning round*, so as to imply the *effect* and not the *manner* of turning; then, as nobody denies that the Moon *turns round* to the Stars, we have to consider whether that *effect* is produced by an *axial* movement about its own center of gravity (only), or whether it be the joint effect of its *orbital* movements round the Earth and round the Sun (with the Earth); or, supposing there were an axial motion as alleged, by all three movements combined: and secondly, what are the individual effects of each movement?

Assuming that the Moon travels round the Earth as the Earth is said to travel round the Sun, and at the same time has an axial movement round her center of gravity, as the Earth is said to have round its axis or center—but only once instead of many times in completing her orbit—what effect would be produced by this double motion, as indicated by turning round to the center of her orbit the Earth, and to objects outside the orbit such as a distant Star?

It may be premised that the double motion attributed to the Moon is precisely analogous to that ascribed to the Earth, with the exception of the comparative slowness of its axial movement; and as Nature is always consistent in her laws, we may apply the same principles to the lunar movements that we do to those of the Earth, confidently relying that similar causes in similar circumstances always produce similar effects.

That diameter of a moving body which at any instant coincides with a tangent to the orbit, or path of the center, always continues tangential when there is no *axial* motion; consequently the deviation of the diameter from the tangent of the orbit, or path described by the center, is the exact angular measure of the *axial* movement called rotation.

Suppose an imaginary line passing through the centers of Moon and Earth; the Moon's surface must periodically cross this line if she turn about an axis perpendicular to the plane of her orbit. Just as the surface of the Earth daily crosses the line of centers of Earth and Sun; with which line of centers the plane of our meridian coincides at noon and midnight.

Suppose a diameter drawn through the Earth's equator, and therefore at right angles to the polar diameter round which the axial movement is performed, this equatoreal diameter and its meridian plane would periodically cross and coincide with the line of centers of Earth

and Sun; the plane twice a day, at noon and midnight, but the diameter only twice a year, at the equinoxes, if the polar diameter or axis be inclined to the plane of the orbit. The angle made by the meridian plane and the plane of centers, through the Earth's axis (called the horary plane), would be the measure of the Earth's axial movement (called the diurnal rotation), and the consequent solar days. The angle of position of the meridian plane with a plane fixed in space perpendicular to the plane of the equator—or the angle made by the plane of a meridian with a line drawn from the Earth's center to a fixed Star—is the measure either of the orbital movement or of the axial movement of the Earth, if it have one of these movements only—or if it has both, it is the measure of the sum or of the difference of the two movements according as they are in the same or in contrary directions. Thus the angle made by the plane of Earth and Sun centers with the plane of centers of Sun and fixed Star is the measure of our sidereal yearly orbitation or circular translation in space; while the angle made by the plane of our meridian with the plane of centers of Sun and Earth is the measure of our daily axial movement; but the angle made by our meridian plane with the plane of centers of Earth and Star is the measures of both our orbital and axial movements conjointly, the two movements being in the same direction, and not of the axial movement only. In other words, our time of year is indicated by the angle made by the plane of centers of Sun and Earth with the plane of centers of Sun and reference Star; our solar time by the angle made by our meridian plane and the plane of centers of Sun and Earth (the aspect of the meridian to the Sun); and our sidereal time by the angle made by our meridian plane with the plane of centers of Earth and reference Star (the aspect of the meridian to the Star).

Applying the same reasoning to the case of the Moon, we find that the angles made with the plane of centers of Earth and Moon by any of her meridian planes are constant, and therefore she has no axial movement. Because her meridian planes move round the Earth as a center, and not round any axis or center within the Moon, her solar time is indicated by the angle made by the plane of centers of Moon and Earth with the plane of centers of Earth and Sun; her sidereal time is denoted by the sum of that angle, and the angle made by the plane of centers of Earth and Sun with the plane of centers of Sun and reference Star. So that in one of our years she has $12\frac{2}{5}$ solar days (each equal to $29\frac{1}{2}$ of ours), and $13\frac{2}{5}$ sidereal days (each equal to $27\frac{1}{3}$ of our mean solar days); the additional sidereal day being due to the orbital revolution about the Sun, and the others to the orbital revolution about the Earth, without any rotation or axial movement about her own center of gravity, analogous to the daily rotation of the Earth.

Experiments are the interpretations of Natural Laws by natural means; and Mathematics of course cannot err; so that when analytical demonstrations give results which are not in accordance with experiments, it will generally be found on investigation that mathematicians have relied upon fallacious Data, or have misinterpreted their symbols or misapplied their formules. This is the case in the present instance, as the Dogma of the Moon's Rotation is dependent on the erroneous *assumption* that the angle made by a diameter of a moving body with a fixed line is the measure of its *rotation* only, instead of the measure of its *revolutions* also; of *one* instead of *all* its circular movements: and this error is fatal to other Doctrines of more importance than the Moon's imaginary Rotation.

H. Perigal, Jun., Nov. 1864.

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November 11, 1864.